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Work on the New Lock and Canal at Sault Sainte Marie, Mich.

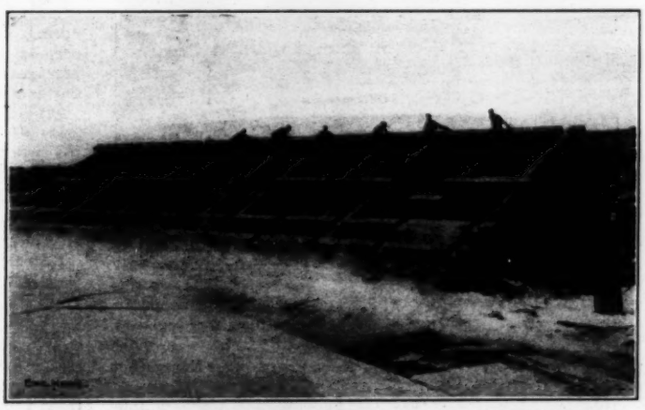
The enormous traffic through the navigable channel at the rapids of the St. Mary's River, connecting Lake Superior with the lower lakes, has exceeded the capacity of the present locks for the prompt and economical handling of the traffic. Owing to the importance of the traffic and the fact that navigation is closed for about five months, rapid handling of vessels is imperative, and a third lock was decided upon some four years ago. Work on this was commenced in 1907, and it is expected that it will be completed in 1914. The work is remarkable for the great size of the lock, the chamber of which is 1,350 × 80 ft., with 24½ ft. of water on the sills, so that it can accommodate two 650-ft. steamers with an aggregate load of 30,000 tons or more. The largest existing steamers are 607 ft. long, but an increase in size is anticipated. Smaller vessels will be handled in proportionately larger numbers. The improvement of the ship channels below the locks was described in our issue of Oct. 10, 1907.

The two present locks are the Weitzel lock, 515 × 80 ft. (1881), and the Poe lock, 800 × 100 ft. (1896). These are side by side and are served by the same approach canal. The new lock will be close beside the old ones, but will have its own approach canals. The general situation is explained by the map, Fig. 1.

In accordance with an Act of Congress, the United States government is purchasing all lands north of the present ship canal out to the international boundary line, including a water power plant now installed on these lands. As the new canal will destroy the present headrace of the plant, and as the United States desires to use the power from this plant to operate the locks and light the canals, a new headrace is being built farther out in the rapids. This headrace will reduce the cross-section of the river open to free flow, and controlling works are being placed at the lower end of the race so that in case Lake Superior should become too high the sluice gates may be opened and permit the water to waste.

The total cost of the new canal and lock, as approved by Congress, is not to exceed $6,200,000. In addition to this, the recent improvements to the present canal have cost about $1,020,000. The appropriation made so far under this act for the new lock and canal amount to $2,725,000. The entire work is under the supervision of Col. C. Mc.D. Townsend, Corps of Engineers, U. S. Army, whose headquarters are at the U. S. Engineer Office in Detroit, Mich. Mr. L. C. Sabin, M. Am. Soc. C. E., is Assistant Engineer in resident charge of the work.

IMPROVEMENTS TO THE PRESENT WORKS.—The original approach canal was spanned by a swing bridge for the Canadian Pacific Ry. and by a swing span carrying a movable emergency dam of the type described in Engineering News of June 24 and July 22, 1909; and here the width was only 108 ft. The rate of filling the locks at the Sault is more rapid than is usual in ship locks, and because of this, and the restricted cross-section of the canal, a strong current was set up in the latter when the locks were filled, making the navigation of the canal difficult at certain times. To remedy this, as well as to provide more room for the manoeuvering of vessels, it was decided to widen the canal, making a new channel on the north side of the center pier of the bridge of the same width as the existing channel on the south side. The swing span of the bridge had been originally planned to meet such a condition, the two arms being made of equal length.



LAUNCHING A TIMBER CRIB (84 x 30 FT.) FOR THE NORTH DIKE OF THE NEW CANAL AT SAULT STE. MARIE, MICH.

The old emergency dam, built for 16 ft. depth in the canal, had been out of use for many years on account of increasing the depth in the canal to 25 ft. in 1898. The island between the two parts of the canal was left in place to support the center pier of the swing bridge and to receive the center pier of a new emergency dam to close both channels. This widening of the canal called for the excavation, to 25 ft. depth, of a strip about 3,700 ft. long and having an average width of about 125 ft.; also the building of about a mile of canal revetment wall, part of which was of concrete and part of timber. The excavation and the building of the concrete walls were done in the dry, the greater part of the area being shut off from the original channel by cofferdams. During the winter season, when the headgates could be closed, that part of the cofferdam between the two channels was removed and the concrete walls were completed.

The upper part of the canal is now about 300 ft. wide, with two 108-ft. channels at the site of the bridge and movable dam, one for eastbound and the other for westbound vessels. The contract for widening the old canal was let to the Great Lakes Dredge & Dock Co., of Chicago, Ill., and the movable dam for the new channel at the bridge was built by the Variety Iron & Steel Works, of Cleveland. This dam has been installed and tested, and all work on the improvement of the existing works was completed in 1911.

NEW LOCK AND CANAL.—The new works will form a complete connecting link between the upper and lower levels, parallel with but entirely independent of the present link (which comprises the canal and two locks). This will be of special advantage, since an accident to the present work (either at the locks or in the canal) might cause serious interruption to traffic. The new canal, now under construction, will be 4,800 ft. in length from its upper end to the lock; it will be from 280 to 350 ft. in width, and will have a depth of 25 ft. of water at low-water stage in the river.

The new lock will be by far the longest in the world. It will be noted, however, that its width (80 ft.) is narrow in proportion to its length, and narrower than the present Poe lock (100 ft.). The reason for this is that experience has shown that the placing of vessels side by side in the lock causes delays in getting them into position and in working them out of the lock. The new lock therefore will take two of the largest vessels (which are the most awkward to handle under these manoeuvering conditions) in tandem position, which greatly facilitates their movements. Cross-sections of the lock are shown in Fig. 3; these are somewhat tentative as far as details are concerned, but no important changes are expected. The designs for the lock gates have been completed, except as to details.

The railway will be carried across the canal by a bascule bridge, but there will be no emergency dam of the type used at the other (parallel) canal. The reason for this is that in the new lock two pairs of gates are operated at each end of the lock, so that the two levels will always

be separated by two closed gates and the possibility of accident under these conditions is thereby rendered so remote that it does not seem necessary to further multiply precautions. The westerly portion of the upper canal is under contract with the MacArthur Brothers Co., of Chicago, and operations are now in progress. The contracts for that part of the canal between the lock and the bridge and for the east entrance have not been let. The contractor for the excavation of the lock chamber is John Marsch, of Chicago, and this work is nearly completed. The pumping required to drain the lock excavation was from 1,000,000 to 3,000,000 gals. daily during 1910. All excavation is mainly in the Potsdam sandstone bedrock. Bids for the concrete masonry of the lock were opened June 29, 1911, the Great Lakes Dredge & Dock Co., of Chicago, being the lowest bidder.

THE CONTROLLING WORKS.—The controlling works include a stone dike or training wall in the river, parallel with the new canal and curving in towards shore at its lower end. In the space between the dike and the shore is a power house that will be used for developing power for the operation of the new lock and lighting the canal, and also a set of three controlling gates. By these gates water can be held back if the Lake Superior level should be low, or additional area for discharge can be given if this level should be too high. There will be three openings 35 ft. wide, fitted with Stoney gates; the gates are being built by the Milwaukee Bridge Co., and will be installed this season.

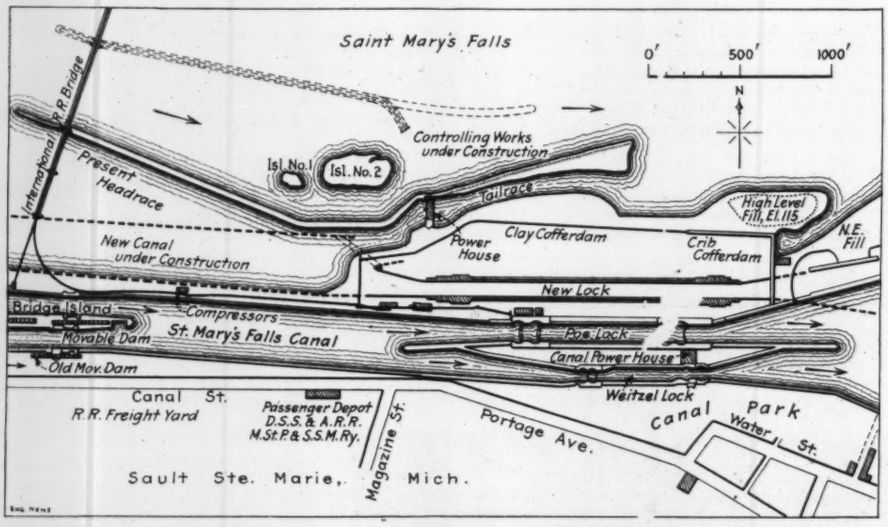


FIG. 2. PLAN OF THE OLD AND NEW SHIP LOCKS AND APPROACH CANALS AT SAULT STE. MARIE, MICH.

CONSTRUCTION WORK ON THE NEW CANAL.—The work already mentioned as being under contract to the MacArthur Brothers Co. consists of (1) the excavation of that part of the canal above the bridge, (2) building canal walls and piers north of the entrance to the present canal, (3) preparing a new headrace and forebay, with controlling works, ice passages and weirs, and (4) removing the existing dikes and building new dikes. It includes dry and wet excavation, building cribs with concrete superstructure, etc. For information as to the method of carrying on this work we are indebted to Mr. E. B. Hitchcock, who is superintendent in charge for the contractors.

Part of the navigation channel is being done in the wet under sub-contract with the Edwards Bros. Dredge Co., which is using a 6-yd. dipper dredge, with tug, flat and dump scows. There are 48,000 cu. yds. of hardpan, gravel and boulders to be excavated in this way, and the material thus excavated has been used chiefly in building cofferdams to inclose areas that are to be excavated in the dry.

The pier along the north side of this part of the channel is built of timber cribs with a concrete superstructure for a height of 6 ft. above the water. The cribs are 11 in number, each 84 ft. long, 20 ft. wide on top, 30 ft. wide on the bottom, and 24 ft. high. The framing of these cribs was done with a gainer driven by a 15-HP. electric motor; this cut gains and dovetails in timbers that had been cut to lengths by a motor-driven cross-cut saw. Erecting on shore and after launching was done with a stiff-leg derrick having an 80-ft. boom. The cribs were built to a height of 9 ft. and then launched and completed in the water. Electric and pneumatic augers were used in boring holes, and a pneumatic hammer in driving drift bolts. All material was furnished by the Government. The view on the front page of this issue shows the launching of one of the large cribs.

After completion, the cribs were placed in position by a tug, leveled, sunk and filled with stone; low places under the edges of the cribs were filled with stone by divers. They were filled by a stiff-leg derrick loading stone with an orange-peel dipper from scows that were unloaded by a derrick scow using a clam-shell dipper. There are 1,645,000 ft. B. M. of timber in the cribs and 2,000 cu. yds. of concrete in the superstructure.

Another part of the navigation channel is to be taken out in the dry, and the area after being inclosed by cofferdams, will be pumped out by a plant consisting of three pumps belted to motors: a 12-in. and a 15-in. centrifugal pump will be driven by motors of 75 and 100 HP., while a 200-HP. motor will drive a 20-in. turbine pump. All motors are three-phase, alternating current, 60-cycle, 440-volt machines. Power is supplied by the hydro-electric plant of the Edison-Soo Electric Co.

For the excavation in this area there will be 14 air drills, power for which is to be furnished by an air compressor 14 × 18 × 22 ins., with a capacity of 1,188 cu. ft. of air per min. and driven by a 250-HP. electric motor. There will be also three channeling machines. For removing material there will be a cableway of 550 ft. span, operated by an engine 12¼ × 15 ins. and using 5-yd. skips. There are three locomotives, 12 flat cars, and 50 air-operated dump cars of 12 yds. capacity; all this equipment is of standard gage. The skips after being loaded by shovel (on traction wheels) will be hoisted by the cableway and the finer material will be dumped into the 12-yd. cars. Coarse material will be left in skips which are loaded on flat cars. These skips will be unloaded by a derrick scow with 75-ft. boom when material is used for back-filling back of cribs, and with a locomotive crane having a capacity of 9 tons at 35 ft. radius, when used in filling borrow pits and widening the banks. Fig. 4 shows the cableway and construction plant.

There are 75,000 cu. yds. overburden and 200,000 cu. yds. of solid rock in this area for excavation in the dry; also 20,000 cu. yds. of concrete in side walls.

The temporary dams and the new dike inclosing the headrace and forebay were built with a 70-ton steam shovel, three 18-ton locomotives, and 25 dump cars of 4 yds. capacity (3 ft. gage); the material was borrowed from the spoil bank made by previous canal excavation. Access to this part of the work was over a trestle built on stone-filled timber or log cribs placed 30 ft. c. to c., and material for dikes and dike was dumped from a trestle built across part of the head and down the rapids of St. Mary's River. Fig. 5 shows this construction trestle and the two parallel dikes for the present and new headrace.

The headrace and forebay having been inclosed by cofferdams, work therein is being done in the dry, using the following plant: 4 steam drills, 38 dump cars (1½ yds.) drawn by horses, 1 hoisting engine, 1 concrete mixer (2½ yds.), 1 gasoline pump and 1 belt-driven 5-in. centrifugal pump with 15-HP. electric motor. There are in this part of the work 2,000 lin. ft. of new dike, 1,200 ft. of temporary cofferdams, 4,000 cu. yds. of concrete in sluice gate masonry, and 20,000 cu. yds. of rock excavation.

Dikes to be moved in this area, as well as temporary cofferdams, will be handled with a derrick scow using an orange-peel dipper for loading and unloading scows. The shop equipment for the whole work consists of a 30-HP. boiler and 8-HP. stationary engine driving a swinging lathe, a bolt and pipe-cutting and threading machine, a power hack saw, a drill press, a drill-sharpening machine, an emery wheel and a blower.

Specifications for Concrete Work on the New Ship Lock at Sault Ste. Marie, Mich.

The contract for the concrete masonry of the new lock will cover about 173,000 cu. yds. of concrete, and we give below an abstract of the official specifications for this work. It is expected that the placing of concrete will be commenced this season, and the work must be completed within 700 days. The specifications require that if the contractor elects not to prosecute the work during the winter season, because of the long periods of severely cold weather, he must proportionately increase the rate of work during the summer.

FOUNDATIONS.—All foundations for concrete shall be prepared by removing from the site of the work all loose, soft and unsound rock to such depth and width as the contracting officer directs. Any water-bearing seams that may appear in the rock shall be specially treated, so that the water shall be led through the masonry in pipes.

LOCK WALLS.—The total length of each lock wall is to be 1,715 ft. Of this length about 1,200 ft. is called the narrow wall, the section of which is 26 ft. wide at the base and about 50 ft. high. The remainder of the wall is for gate abutments and recesses, and the several parts of it are referred to as wide walls. The walls are to be founded on solid rock and are to be built in sections from 25 to 35 ft. in length, alternate sections being built first and the intermediate sections later. Between adjacent sections of wall shall be placed two thicknesses of gravel-coated asphalt roofing paper, with burlap core, or other material acceptable. Such abutting surfaces shall also be provided with suitable expansion joints by molding tenons into the blocks first built, to be filled when the alternate sections are placed.

Near the back of each joint between adjacent blocks an efficient sheet lead stop-water shall be built into the concrete, extending into each block not less than 6 ins., with a bend at the joint providing for slight expansion. This lead shall form a continuous strip from the bottom of the joint to within about 1 ft. of the top of the wall. Special care shall be taken in placing this strip to prevent injuring it, and to assure contact with the rock at the bottom and thorough imbedment in the concrete throughout its length. All passages through the walls and all recesses shall be accurately made and surrounded with reinforcing metal in accordance with detail plans. The interior surfaces of such passages and openings shall be finished smooth and the exposed angles protected with cast-iron boxing or neatly

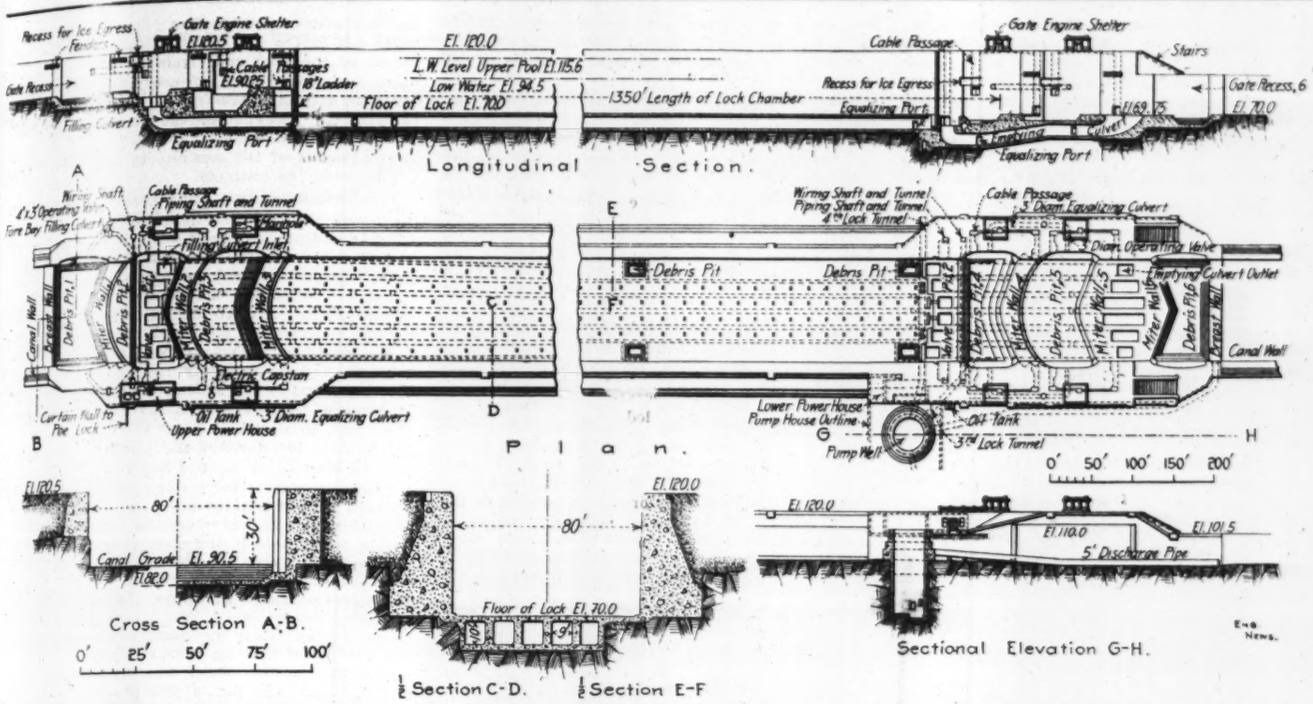


FIG. 3. PLAN AND SECTIONS OF THE NEW LOCK AT SAULT STE. MARIE, MICH. (LOCK CHAMBER 1,350 x 80 FT.).

rounded or chamfered. The concrete around hollow quoins shall be placed with special care to secure watertightness, and special stop waters shall be used as required.

LOCK FLOOR, CULVERTS AND MITER WALLS.—The lock floor is in general about 1½ ft. thick, covering the area between the lock walls. The culverts or tunnels are about 9 x 10 ft. in cross section; they extend under the floor throughout the greater part of the length of the lock and are separated by concrete walls. The miter walls extend across the lock to support the gate sills, and are from 5 to 20 ft. high and 12 ft. or more in thickness. The lock floor, where it does not form culvert covers, shall be, in general, laid in sections not exceeding about 20 ft. in length. Adjacent blocks shall be laid with joints about ¾-in. wide, which shall be filled later with asphalt.

The culverts are to be built in sections of the entire width, including six or four culverts. It is probable that such sections may be about 35 ft. in length. The miter walls, breast walls, bulkheads and other cross walls shall be made of monolithic blocks of sizes indicated on the plans and molded in place by continuous work. In general, provision is made for a vertical joint in the plane of the lock axis and lead stop-waters are to be placed in such vertical joints in the miter walls. In special cases where miter or other cross walls are built over the culverts and the volume of concrete is too great to be satisfactorily made in one block, the horizontal and vertical joints shall be made satisfactory to the contracting officer, and such bond blocks, stop waters and extra reinforcement used at these joints as he may direct.

CANAL WALL.—The work includes building, on the rock, within the cofferdam limits, short reaches of canal wall adjacent to the lock. These walls shall be founded on solid rock and shall be built in alternate sections as specified for lock walls. Between consecutive sections shall be placed layers of gravel-coated asphalt roofing paper, with burlap core, or other acceptable material, making a thickness of about ¼-in. In general, each section shall be built as a monolith, concrete once started being continued until completed, but the contracting officer may grant permission to place the section in two lifts with such precautions as to bond between horizontal layers as he may require.

TUNNELS, ETC.—The work includes the lining of about 325 lin. ft. of tunnel in rock, estimated to require about 1,000 cu. yds. of concrete, and the building of about 170 lin. ft. of tunnel in trench, in addition to the tunnels and passages through the masonry. It also includes the lining of the pump well. Special care shall be taken in the construction of all tunnels and linings, so that the concrete shall be practically waterproof. The work shall be made as nearly continuous as possible, and metal stop-waters shall be placed in all joints. The work of lining the pump well must be so prosecuted as to facilitate the placing of machinery, platforms, etc.

PLACING METAL AND APPURTENANCES.—All metal and other parts to be imbedded in the masonry shall be set to line and grade and securely fastened in place. Special care will be required in the setting of gate anchorages and reaction bearings, machinery foundations, etc. The holes for anchor rods to enter the rock shall be drilled in the position and to the depth given, and of such a size that the rod will give the best resulting holding power when grouted in place. The anchor bolts required to secure the machinery shall be set accurately in light iron, tin or fiber tubes imbedded in the concrete.

CEMENT.—The cement shall be a true Portland cement, suitable to work of the highest quality, conforming with "Specifications for American Portland Cement" in Professional Papers No. 28, Corps of Engineers, U. S. Army, pages 30-33, second edition, with the following modifications:

Adulteration: no addition shall be made to the cement after calcination, except for the purpose of regulating setting, and such addition shall not exceed 3% by weight of the calcined product. Color: if more than one brand is used the colors must be such as not to show marked variations in appearance of the completed work. Fineness: it shall leave a residue of not more than 25% on a sieve having from 188 to 200 meshes to the inch made of brass wire of 0.0024-in. diameter. Tensile strength: mortar containing 3 parts standard Ottawa sand to 1 part cement, thoroughly mixed with sufficient water to make a plastic mortar and pressed into molds with the fingers; briquets shall show a tensile strength of not less than 175 lbs. when 7 days old and not less than 275 lbs. when 28 days old. The cement shall not contain more than 1.75% anhydrous sulphuric acid ($S. O_3$), nor more than 4% of magnesia ($Mg O$).

SAND.—The sand shall be composed of varying sizes of sound hard grains. It shall be free from loam, decayed rock and other injurious substances.

BROKEN STONE.—The broken stone shall be crushed from trap or other equally sound hard

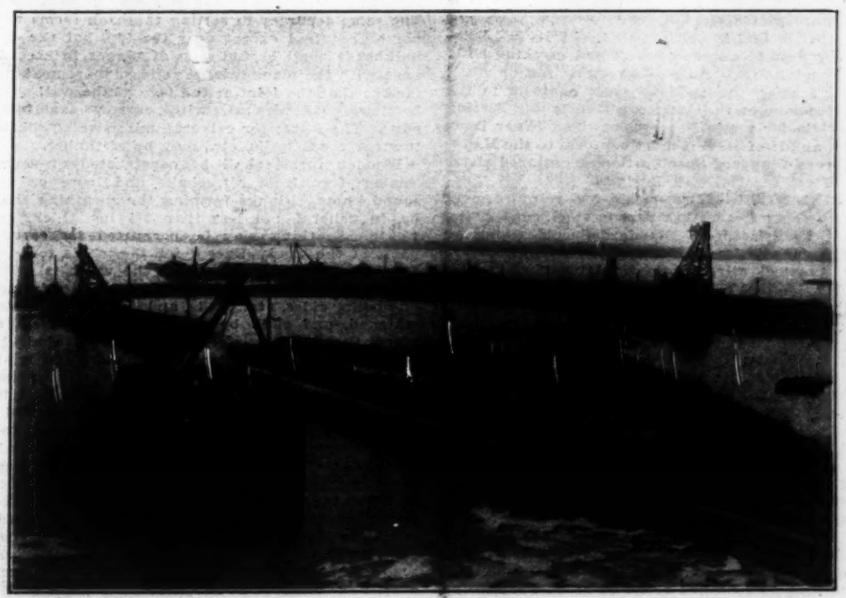


FIG. 4. WORK ON THE UPPER END OF THE NEW SHIP CANAL AT SAULT STE. MARIE, MICH. (LOOKING NORTHWEST).

(The cableway spans the excavation, which will be taken out in the dry. Beyond the cross cofferdam [just above the cableway] is a dredge excavating the work taken out in the wet. The dredge in the foreground is in the present canal.)

igneous rock, and shall be free from loam, decayed rock and other injurious substances. The stone shall be of such a character as to break in fragments approximately cubical in shape, not flat nor elongated, and not having incipient cracks, but suitable in every way for first-class concrete. The stone shall be separated into two sizes; the pieces in the "coarse" size shall pass a ring 2¼ ins. diameter and not pass a ring ¾-in. diameter. The "fine" size shall be composed of pieces that will pass a 1-in. ring and contain the dust ordinarily resulting from crushing. It is expected that practically the entire run of the crusher will be used in the concrete work, but if the stone is of such a character as to give too great a proportion of either size as above outlined, the contractor may be required to change the crusher jaws or method of separation of the sizes to accomplish this result. As indicated elsewhere, alternative bids are requested for concrete composed of softer aggregate, such as limestone, and if the prices submitted for concrete made with aggregate of igneous rock, such as trap, or granite, are considered too high, the United States reserves the right to accept softer aggregate, such as limestone, for a portion of the work. The use of gravel, from granite or other hard rock, in place of a portion (not exceeding 25%) of the broken stone may be permitted.

STEEL BARS.—Bars for reinforcement shall be square cold twisted, low carbon bars, rolled from open hearth billets only (not rerolled rails), and before twisting shall conform to the Manufacturers' Standard Specifications for "Steel for Railway Bridges." After twisting they shall have an elastic limit not less than 50,000 lbs. per sq. in. The use of other styles of deformed bars may be permitted if they conform to the above specifications for twisted steel.

ANCHOR RODS AND FOUNDATION BOLTS.—Anchor rods to enter the rock and machine bolts for foundations may be of wrought iron or steel; if the former, the material must conform to the specifications of the American Society for Testing Materials for grade B. merchant iron (Year Book 1910), and if of steel it must conform to the Manufacturers' Standard Specifications mentioned above for "Steel for Railway Bridges."

WIRE MESH.—Wire mesh for reinforcement shall be open-hearth low carbon steel, conforming to the Manufacturers' Standard Specifications for "Steel for Railway Bridges" above mentioned. The "heavy" wire cloth shall weigh approximately 1.5 lbs. per sq. ft., and the "light" wire cloth about 0.5-lb. per sq. ft., the meshes being about 4 ins. Either triangular or square mesh may be employed, but the joints of the fabric shall be firmly fastened by tying or welding, and the style of fabric shall be subject to approval.

CONCRETE.—The cement, sand and broken stone shall be mixed in such proportions as may be directed. The amount of the "coarse" size of broken stone will greatly exceed the "fine" size, the object being to obtain a mixed aggregate with as few voids as possible. The mortar will ordinarily be made from 1 part cement and 2 to 3 parts sand by weight, and the proportion of mortar used in the concrete will be somewhat in excess of the voids in the aggregate. Mortar composed of cement and sand, and granolithic containing fine broken stone must be supplied as required for special purposes, but such mortar and granolithic will not exceed 3% of the concrete. The measurement of materials will be by bottomless boxes in which the materials may be cast and leveled off; by a properly constructed double gate in a bin chute; or by the use of suitable carts or barrows having square or cylindrical bodies expressly designed for this purpose.

MIXING.—Concrete, in general, must be mixed by a batch mixer of approved form. The materials for each batch shall be accurately determined as specified above, and the aggregate shall be wet, if required, before being placed in the mixer. In general, the consistency of the concrete shall be such that it will quake after it is well rammed in place. The concrete shall be transported from the mixer to the place it is finally to occupy in the work with promptness and in such a manner as not to separate in any degree the component parts. The contractor shall install a plant capable of placing not less than 80 cu. yds. per hour.

FORMS.—The forms for the main faces of the lock walls shall be built of steel of acceptable design. They shall be so rigid as to permit making the faces practically true planes in conformity with the plans, with a variation of not more than ¼-in. They shall be provided with jacks or other suitable device to permit realinement during the progress of the work. If concrete work is done in freezing temperature these forms must have a light sheathing outside of the main vertical or horizontal beams or wales, or must be otherwise so arranged as to permit heating the main sheathing to a temperature of at least 35° F. and maintaining this temperature until the forms are removed and the finish completed.

FIG. 5. VIEW OF THE WORK AT SAULT STE. MARIE, MICH.; LOOKING EAST (DOWNSTREAM).
(At the second pier of the bridge is the dike of the present headrace; at the fourth pier is the new dike to the controlling works [see Fig. 2]).

The forms for gate recesses may be of timber, but, if so, they must be exceptionally heavy so as to hold their position accurately during the placing and setting of the concrete. The back faces of the wall forms and the bulkheads forming the ends of the blocks may also be of timber. The same accuracy in setting the back forms will not be required except near the top, but the end bulkheads shall be built up of planes in accordance with the plans, with a rigid support next the face so that the joint at the face of the wall shall be true and vertical, with narrow chamfered edge. The forms for culverts, miter walls, shafts, tunnels, canal walls, etc., may be of timber.

Wooden forms shall be constructed of sound lumber, free from rot, shake and loose or unsound knots. Planks forming the sheathing shall be, in general, not less than 2⅝ ins. thick, but 1¾-in. sheathing may be permitted for certain parts of the work. Except for the molds forming the back of the walls where the work is to be backfilled, the sheathing plank shall be dressed on both sides, tongued and grooved, center matched, and shall be neatly butted. When in place the inner surface of the mold shall be smooth and even. In case two or more end joints in adjacent planks are in the same vertical plane, special precautions shall be taken to prevent a lip or fin on the concrete. Where planks are used a second time they shall be thoroughly cleaned, and, if necessary, the edges and ends shall be freshly jointed. The use of slab forms, where the sheathing is built up in large areas, with the intention of using them many times, will not be permitted, except on the back of the wall, where the finish is of less importance. The posts and braces shall be of sufficient strength to make a practically unyielding support to the sheathing. The forms shall be so secured at all parts as to permit their removal without danger of injuring the concrete in any way. With wooden forms where tie rods are permitted and are intended to remain permanently in the concrete, the tie rods must be provided with sleeve nuts or other suitable connections, such that the rod does not extend nearer the face of the concrete than 2 ins., and the small holes left in the face of the concrete [illegible] the removal of the stub ends from the [illegible] nut or other fastening shall be properly filled with mortar soon after the removal of the forms. Before the placing of the concrete the interior of the mold shall be treated with a suitable coating to prevent adhesion of the concrete to the mold without staining the concrete.

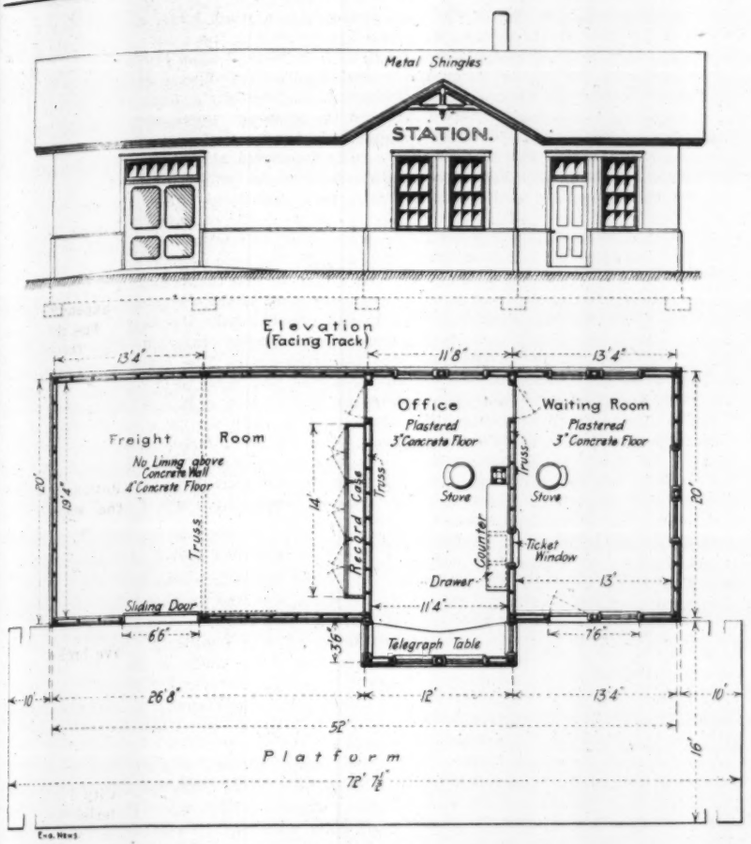
PLACING.—Before placing concrete in contact with rock the latter shall be thoroughly cleaned of loose and unsound rock and debris of any kind and washed with water under pressure. A thin layer of mortar shall be spread on the rock, filling all cracks, and coating the surface just before placing of concrete begins. In case it should become necessary to join fresh concrete to a surface already set, where a bond is desired, such surface shall be similarly treated. Where concrete is placed on top of sheathing, as in the roofs of tunnels and culverts, a layer of granolithic shall first be placed, in order to insure a smooth finish to the interior, and the concrete above shall then be thoroughly tamped into it.

The arrangement for placing the concrete shall be such that it will be under perfect control at all times, and the concrete shall be dumped as nearly as possible in the place it is to occupy in the work, in layers not exceeding 8 ins. in thickness. It shall be so deposited as not to separate the ingredients and not injure the molds nor the concrete already placed. The layers shall be kept, in general, as nearly horizontal as may be during the process of placing, unless otherwise ordered by the contracting officer, one layer being completed before another is started, and layers of concrete must not be run out to a thin edge. The successive layers of concrete shall be thoroughly kneaded and rammed with iron rammers having a face of about 3 × 6 ins., and weighing about 30 lbs., or by other approved means. Such special rammers and forks shall be used near the face as may be required to give the desired finish, and similar care shall be taken in placing concrete against a rock face where a bond is desired. Concrete shall not be deposited in water except with permission for each case.

In case the body of the lock walls and other massive work is built of concrete with softer aggregate, such as limestone, and faced with concrete in which the aggregate is trap or similar rock, the softer concrete shall not be placed nearer the face or top of the mold than 2 ft. A layer of the harder concrete shall be placed next the mold along all exposed faces, this layer being 2 ft. wide on the top and 3 ft. wide on the bottom. The remainder of the mold shall then be filled with the softer concrete to the same level, special care being taken to ram and knead the layer at the point of joining. A second layer of the harder concrete, of the same width, shall then be placed next the exposed face and the layer completed with the softer concrete as before, and the operation repeated until within about 3 ft. of the top of the wall. At this point the last layer of softer concrete will be placed in ridges across the mold, forming a partial layer only, and extending no nearer the top than 2 ft., the layer will then be completed with the harder concrete and the two kinds thoroughly bonded by tamping, after which the remaining 2 ft. is to be completed with the harder concrete.

The contractor will be permitted to imbed in Class A concrete "plums" of limestone trap or other sound rock. Such stone if used must be perfectly sound, of good shape and well cleaned and wet before placing. This stone shall be distributed throughout the concrete so as to avoid joints of weakness; shall not be placed nearer than 2 ft. to an exposed face or any metal reinforcement or adjoining plum, and shall not exceed in volume 25% of the section.

FINISH.—The exposed faces of the concrete shall be finished smooth without visible voids. This must be accomplished by proper precautions in placing the concrete next the forms, by pressing the stones slightly back from the sheathing so that no voids shall appear, and by thorough ramming and kneading. To form the top surface, enough concrete shall be placed to bring the top to within about 1 in. of the required elevation, and immediately thereafter and before final tamping, a small amount of granolithic shall be spread over the top to complete the work. This granolithic shall contain only the finer part of the hard broken stone or screenings mixed with sand and cement. Such granolithic shall be thoroughly tamped and worked into the underlying concrete; it shall be struck off with a straight edge to bring it to a true plane surface, and as soon as in proper condition it shall be given a rubbed sand finish by the use of wooden floats.



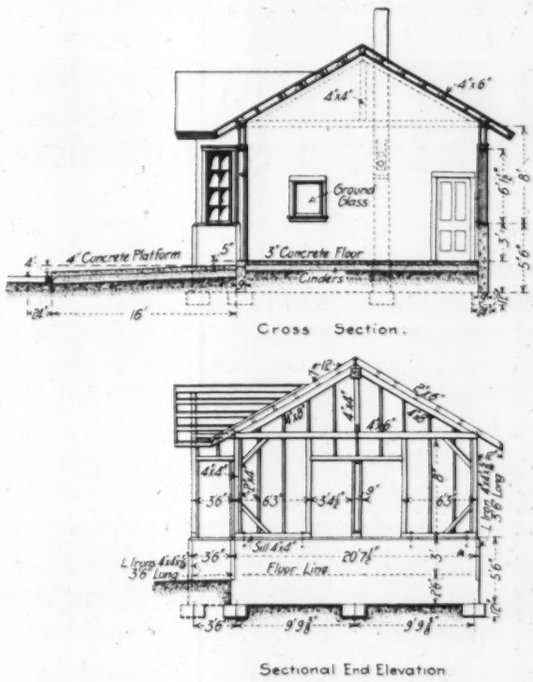


FIG. 1. COMBINATION PASSENGER AND FREIGHT STATION OF LIGHT REINFORCED-CONCRETE CONSTRUCTION; WABASH RAILWAY.

(A. O. Cunningham, M. Am. Soc. C. E., Chief Engineer.)

After the removal of the molds all faces of the concrete that are not to be concealed from view shall be given a rubbed sand finish as specified for the coping, and must show a uniform color and texture. This includes the top and face of lock and canal walls, the surface of the floor, the surfaces of all miter and cross walls and valve pits, and the entrances to all openings or passages, port openings, etc. Special care shall be taken to secure, without subsequent patching, a perfect curve at the outer edge of the coping of all walls. This portion of the mold shall be so attached that it may be removed at any time to permit the finishing to be done. The interior surfaces of the culverts, cable passages, tunnels and other openings that are to be closed from view, shall be finished smooth, all fins and irregularities being removed, but need not be given the rubbed finish specified for exposed faces. All finishing shall be done in a first-class manner by competent concrete finishers, and all finished surfaces shall be properly protected by canvas covers or other suitable arrangements.

REMOVAL OF MOLDS.—Molds shall in general remain in place about three days, but whenever considered necessary or expedient, this time may be increased or diminished. After the removal of molds the concrete shall be kept damp for ten days by covering with burlap and wetting same frequently, or by other approved method.

WINTER CONCRETE.—Whenever concrete is placed at such a time that the contracting officer considers special precautions are necessary to prevent freezing, the contractor must provide ample steaming capacity and make such other special preparations as may be required to secure as good work as is done at other times. All frost shall be removed from the crushed stone and gravel, the sand and water shall be heated to 150° F.; the mixer shall be housed and the concrete delivered and placed while warm; the forms shall be specially constructed to protect all parts of the concrete from injury by frost, and radiators or live steam shall be used within the form sufficient to keep the temperature above 35° F. during, and for at least three days after, the placing of concrete. The forms must remain in place much longer than in warm weather. In addition to the above, such other precautions shall be taken as may be found necessary to secure first-class work in every respect, including the character of the finish of all exposed faces.

Standard Design for Reinforced-Concrete Railway Stations; Wabash Ry.

Reinforced-concrete construction of a light and economical type has been adopted by the Wabash Ry. for stations of the smaller class. This type of construction is shown in Fig. 1, which represents the standard design of combination passenger and freight station. Fig. 2 shows some of the details. It will be seen that 9-in. concrete walls extend from the foundations to the level of the window sills. Upon these walls is erected a wood framework with ordinary studding. On each side of the studding is placed steel lathing, and the outside lathing is plastered on both sides with a mortar of 1 Portland cement and 2 parts sand, to which has been added a little hydrated lime. This forms an exterior wall about 2 ins. thick. The exterior is floated to a rough finish and left in the natural color.

The interior lathing is plastered in the usual way. The roof is of wood construction, and has a wood sheathing, covered with metal shingles. The floor is of concrete, and there is a 5-in. step from the waiting room to the concrete platform. The construction is sanitary and fireproof as the ceiling is carried up with the roof line, leaving no openings in which fire can start. Particular attention is paid also to the chimney, which is of concrete reinforced with rods and has a slab surrounding it at the roof line so as to dissipate the heat. All concrete is left in its natural color; exterior woodwork is painted black, and the roof is painted red. The cost of the station building complete averages about $1.40 per sq. ft.

This type of construction was adopted at the instance of Mr. A. O. Cunningham, M. Am. Soc. C. E., Chief Engineer of the Wabash Ry., and has been applied to other designs of small station buildings.

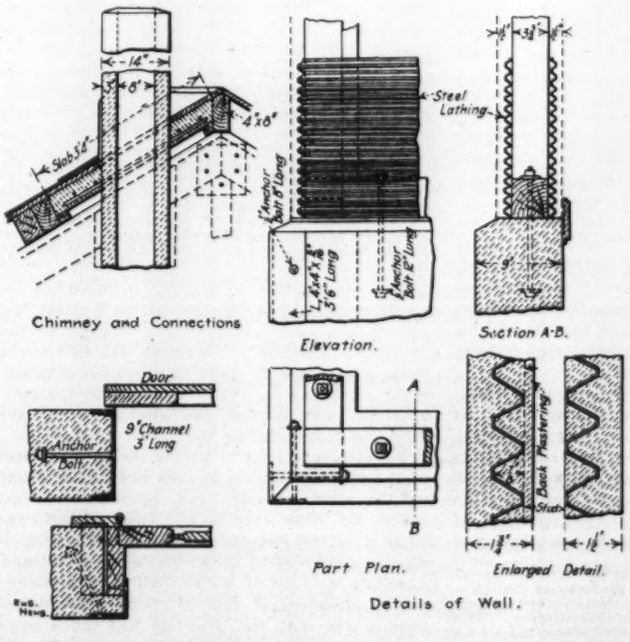


FIG. 2. DETAILS OF REINFORCED-CONSTRUCTION FOR STATIONS; WABASH RY.

The Chicago Commission on City Expenditures.

By CHARLES E. MERRIAM.*

Six years ago it was my privilege to make for the City Club an inquiry into the municipal revenues of Chicago. At that time there was serious discussion as to whether revenues or expenditures should be taken up, but the lot finally fell upon revenue. In the Charter Convention which met shortly after this, I introduced and secured the passage of a resolution calling for an inquiry by the council into city expenditures; but no such action was taken. In the second Charter Convention I again introduced and secured the passage of the same resolution, but with the same result. In 1909 an effort was made by representatives (including the writer) from various clubs to organize a Bureau of Municipal Research for the purpose of inquiring into the expenditures of the city and other local governing bodies; but this effort also was abortive. In the same year I entered the Council and in this capacity, as Alderman was able to bring about the investigation.

It so happened that the Legislature of 1909 increased the borrowing power of the city by about $16,000,000, and conditioned the issue of new bonds upon a favorable referendum vote. On the Monday following the signing of this bill, I introduced a resolution calling for comprehensive inquiry into the expenditures of Chicago. I stated that as a referendum vote was soon to be taken upon city bonds, such an investigation was entirely appropriate. If the finances of the city were in good condition, the people should be so informed; and if in bad condition the voters were equally entitled to the information. To vote down the resolution and to pass it were equally dangerous, but it was finally decided to pass it. On June 28, 1909, the ordinance passed as follows:

That the mayor be and he is hereby authorized to appoint a commission of nine persons, of whom not less than three shall be members of the city council, for the purpose of making a comprehensive inquiry into the expenditures of the city of Chicago, and of making appropriate recommendations to the mayor and the city council upon this subject;

That all the heads of departments, and city officials and employees, are directed to supply, on request of said commission, all books, documents, and other information in their possession relevant to the purpose of such inquiry.

The following persons were appointed by the Mayor: Aldermen, C. E. Merriam, Bernard W. Snow and Nicholas Finn; Walter H. Wilson, City Comptroller; Frank I. Bennett, former Chairman of the Finance Committee; Walter Fisher, Special Traction Counsel for the city (now Secretary of the Interior); John W. Alvord, M. Am. Soc. C. E., Wm. A. Tilden, David R. Forgan, George Tunell and A. C. Bartlett. The appointment of a representative of labor was agreed upon, but not made. As the originator of the movement, I was elected Chairman of the Commission; Spurgeon Bell was made Secretary. A steering committee of four was appointed for the purpose of preparing and presenting material to the full commission. This committee consisted of Aldermen Merriam and Snow, Walter Fisher and George Tunell. An appropriation of $10,000 was made for the work of the commission, and this was later increased by an appropriation of $50,000. An attempt was made to enjoin the commission from the use of these funds, but Judge Windes declined to grant the injunction.

The work for the Commission was done by capable experts and investigators employed for that purpose. The work on the city budget was done by Herbert R. Sands, who had been employed in a similar capacity by the New York Bureau of Municipal Research; on sewer cleaning and shale rock by Benj. Walton, of the New York office of Commissioner of Accounts; on the Department of Electricity, by W. H. Zimmerman & Co., of Chicago; on water-works, by Dabney H. Maury, M. Am. Soc. C. E., President of the American Water-Works Association; on street paving, by Samuel Whinery, M. Am. Soc. C. E., one of the best-known paving engineers in the country; on street cleaning, by Richard Fox, head of the Citizens' Street Cleaning Bureau and one of the best authorities on that subject. Preliminary investigations were followed in most cases by public hearings before the Commission, at which opportunity was given for explanation of conditions disclosed by the inquiry, or for obtaining further pertinent information.

The reports of the Commission, as soon as completed, were transmitted to the Mayor and the Council. They were also printed and circulated, with the exception of the reports on Water, Street Cleaning, Special Assessments, Civil Service and Pensions. In all 21 reports were presented as follows: (1) Budget; (2) Purchase of Lumber; (3) Lawrence Ave. Sewer; (4) Purchase of Coal; (5) Bureau of Sewers; (6) Bureau of Bridges; (7) City Clerk's Office; (8) City Purchasing Agent's Office; (9) Purchase of Castings; (10) Fire Department; (11) Police Department; (12) Building Department; (13) House of Correction; (14) Department of Electricity; (15) Street Repairing; (16) Street Paving; (17) Street Cleaning; (18) Southwest Land and Lake Tunnel; (19) Special Assessments; (20) Civil Service; (21) Pensions.

City Budget.

One of the first pieces of work undertaken by the Commission was the revision of the methods of city budget making. Under the old system many of the appropriations had been made in lump sums in such a way as to make effective control of the appropriation impossible. By way of illustration, in the Police Department $205,000 was appropriated in the 1909 budget under the following title:

For repairs and renewals of wagons and harness, replacement and keep of live stock, identification, police telegraph expenses, rents, repairs and renewals of equipment, hospital service, printing and stationery, secret service, light and heat, and twenty-five more horses and equipment for mounted police and for repair of Hyde Park Station; also other miscellaneous expenses, the sum of $205,000.

We subdivided this under various heads in the 1910 budget as follows: (1) General supplies; (2) Material for repair and replacements by departmental labor; (3) Repairs and replacements by contract or open order; (4) Apparatus, machinery, vehicles, harness, etc.; (5) Purchase of furniture and fittings; (6) Purchase of horses; (7) Rents; (8) Fuel; (9) Forage, shoeing and boarding horses; (10) All other operation.

Another illustration may be given from the Bureau of Sewers. In the 1909 appropriation, $200,000 was appropriated under the following caption:

Cleaning sewers and catch basins, District No. 1, old city wards 1 to 5, 9 to 11, and 16 to 23, inclusive. District No. 2, Town of Lake, wards 29 to 32, inclusive. District No. 3, Town of Hyde Park, Wards 6 to 8 and 33, inclusive. District No. 4, Lake View, Wards 24 to 28, inclusive. District No. 5, Austin and part of old city wards Nos. 12 to 15, 34 and 35.

This enumeration of districts included all the wards of the city of Chicago, and they might just as well have said "for the City of Chicago, Bureau of Sewers, $200,000." We subdivided this into a number of heads in order to ascertain definitely what particular portion of money was appropriated for each purpose, and also to control the fund designated during the entire fiscal year.

We were successful in having the entire budget of the city reorganized on this new basis, giving us the most scientific and up-to-date budget which we have ever had. This method was adopted by the Finance Committee, and the budget was approved by the City Council of Chicago. Accounts were set up corresponding to the different sub-divisions of appropriations. The consequence was that last year we had much more effective control over the city finances than ever before.

We also succeeded in making another budget change. For many years it had been customary to appropriate a much larger amou[nt] than would be available during the year. The[se] are called "hot air" or "paper" appropriations [which] no useful purpose and were misch[ievous] in their influence on the city's finances. [The] system placed a premium upon early [expen]diture of funds by a bureau or department. [The] chief who carefully conserved his appropriat[ions] or supplies might discover in October or Nov[ember] that city funds were exhausted, while the [careless] head who spent his funds early in the s[eason] met with no such disappointment. The in[evitable] effect was detrimental to economic expe[nditure].

The action of the Commission m[ade] it possible to squeeze most of the water out of the city budget, and consequently the temptation to spend departmental funds early in the season was greatly weakened. The effect upon the city's finances was excellent, as it enabled the careful bureaus to follow a policy of thrift and saving without being punished for it at the close of the year. One of the indirect consequences of this work was the defeat of the budget in 1911 because of the fact that it contained an over-appropriation so large that it would have broken down the new system.

Contracts and Purchase.

One of the important branches of the Commission's work was the investigation of purchases of material and supplies, and the letting and enforcement of city contracts. This involved an examination of the office of the City Purchasing Agent, and of contracts for material and work in the various departments of the city government, particularly the Department of Public Works.

Purchases of material and supplies for the various departments are made through the City Purchasing Agent's office, when the amount is less than $500 without a formal contract. Inquiry into the operations of this office disclosed the existence of many serious abuses. One of these was the so-called "split requisition." This is a device for evading the requirements that purchases above $500 in amount be made by contract. For example, a purchase of $10,000 is split into sums less than $500, and no public bidding is required on contract made. In the case of castings, a contract for which bids had been taken by the Department of Public Works, was ignored, and material was purchased by requisition at a higher figure than the contract called for. This transaction alone cost the city about $64,000.

It was also discovered that a large miscellaneous business was given to a political brokerage firm whose president was the private secretary of the (then) mayor. This company was upon the favored list and sold a large quantity of miscellaneous articles at high prices to the city. In the case of oils, it was found that prices paid were higher than offered by other companies, and the material furnished uniformly below specifications, as shown by the city's own tests. Purchases of coal, grain, etc., showed similar irregularities, and demonstrated clearly the demoralized and unsystematic condition of the office. The press demanded the resignation of the Purchasing Agent, but no action was taken. In view of this situation I did not press the Commission's ordinance providing for a central purchasing agency, increasing the power and responsibility of the head.

Purchases by contract were carefully examined by the Commission. This inquiry covered the drafting of the specifications, the bidding upon the specifications, and the actual enforcement of the terms of the contract. It showed the existence of conditions which were enormously expensive to the taxpayer, and a disgrace to the city. In the street-repair contracts, declared by our expert, Mr. Samuel Whinery, to be the most openly fraudulent he had ever seen, the chief difficulty was with the specifications and the bidding. The unbalanced bid was the chief source of trouble. The specifications in this contract provided that "no bid will be accepted which does not contain an adequate or reasonable price for each and every item named in the schedule of prices."

Repairs were divided into two classes: Class A

*Professor of Political Economy, University of Chicago, and an Alderman of the city of Chicago. The commission to which the article refers is popularly known as the Merriam Commission. The substance of this paper has been presented in an address delivered before the City Club, of Chicago, by Prof. Merriam. The commission has now passed out of existence, but its work is being carried on by the Chicago Bureau of Public Efficiency. This latter organization is dealt with elsewhere in this issue.—Ed.

included repairs where any surface and binder were required; Class B included repairs where in addition to surface and binder, a 6-in. Portland cement concrete base was required. The successful contractor bid $1.75 per sq. yd. for Class A and 1 ct. per sq. yd. for Class B. Averaging the bids the result is 98 cts., and this contractor was accordingly awarded the contract. If, however, the bid of the next lowest company had been accepted, the city would have saved $147,183, using the estimates on which payment was actually made. These figures were: Class A, $229,891; Class B, $12,064. The percentage of Class B to Class A repairs during a series of years is as follows:

1903	344.2	1906	132.9
1904	200	1907	4.3
1905	336	1908-9	5.2

Mr. Whinery estimated that repairs at the intersections of 44th Ave., which actually cost $2,997.91, should have cost $11.88. Evidently the methods of measurement of areas repaired and the classification of repairs were not calculated to protect the interest of the taxpayer.

In the street lighting contract, providing for 6,000 gasoline lamps, the difficulty was with the inspection. The city did not even possess the "portable photometer" necessary to make the tests, and allowed the contractor a free hand. Our tests showed that instead of a guaranteed candle power of 60, the average was 19 as shown by one set of tests and 26 by the other. No deduction was made for failure to furnish the light guaranteed and the loss incurred for this cause was estimated at $85,000.

In the case of street-paving contracts, the difficulty was double. In the first place, specifications were imperfectly drawn; notably in the case of wood-block specifications, which were so arranged as to invite a monopoly of the business. In the second place, the enforcement of the contract requirements was defective, as the inspection of the work was shown to be grossly inadequate. Case after case of improper work was reported under the very eye of the city inspector, indicating extreme laxity in inspection, and suggesting connivance between certain contractors and inspectors.

In the "shale rock" cases,* 23,000 cu. yds. of rock excavation (25% of the total excavation) was paid for at $2 per yd., where investigation by the Commission and later by the office of the State Attorney showed that clay had been taken out. In this case the inspection of the work was again at fault, as more careful investigation of the quality and quantity of material taken out would have prevented the difficulty which arose.

In the two coal cases, the typical defects were almost all disclosed. The specifications were antiquated, the system of tests provided was out of date, the enforcement of the tests was lax, while the system of checking bills rendered (in the Fire Department) was inadequate to the point of absurdity. Discrepancies discovered in this connection were of three principal varieties: rejected items, varied items, and inserted items. A case involving all three sorts was disclosed at one fire engine company. On April 24 (under ticket No. 4,847) coal to the amount of 232,200 lbs. was received and entered on the books of the company. This was paid for three times; on the charge of that date, on the repeated charge of May 25, and on the charge of May 29, which include a second repetition of it. Other illustrations of the practice are given in the Commission's report on the Fire Department.

The purchase of hose in the Fire Department is an illustration of a different kind. In this case the material, mainly hose, was purchased without any definite specification, but by the market brand. The brokerage company already mentioned again figures as one of the firms whose brand was acceptable. The specifications of the National Board of Fire Underwriters have since been adopted, with some modifications. An entirely different class of contract was that unearthed in the House of Correction. Contracts for contract labor are made at the absurdly low rate of 25 cts. per day per man in certain cases.

*Lawrence Avenue Tunnel and Conduit.

It was found that 60 to 100 men are employed at 25 to 35 cts.; 60 to 100 at 40 cts.; and 60 to 100 at 50 cts. No bids for the services of prisoners have been solicited and there was no competition in awarding the contracts.

The Southwest Land and Lake Tunnel of the water-supply system was another illustration of inadequate inspection service. The investigators of the commission disclosed the fact that the concrete lining of the tunnel was in many instances below the contract requirements as to thickness. Difficulties encountered in Sections 1 and 2 of this tunnel had led to the framing of stringent specifications, but notwithstanding this experience, lax inspection nullified the new specifications. Investigation also showed that the quality of concrete used and the methods of applying it were not such as were called for by the plain provisions of the contract.

These evils may be grouped in a general way as follows: (1) Defects in the specifications themselves, due either to careless continuance of old specifications or to the collusion with contractors. (2) Failure to secure wide competition from a number of bidders. (3) Failure to enforce the terms of the contract either because of general inefficiency of inspection or because of collusion with contractors.

Pay-Roll and Labor.

The Commission's investigation covered the efficiency of expenditure for human service in many important departments. The police force and the law department were important exceptions. Special attention was given to the Bureau of Sewers, the Bureau of Streets, the Bureau of Bridges, the water-pumping stations, inspection services in the several departments, and the practical workings of the Civil Service Law.

The first inquiry covered the Bureau of Sewers and was conducted by Mr. Benj. F. Welton, who had been carrying on similar work in the office of Commissioners of Accounts in New York City. He undertook to test the efficiency of the sewer-cleaning gangs of the city in a series of observations, public and private. His investigators reported to him a deplorable state of affairs in this branch of the city's service. His tables showed that under secret observation the working time of the men was 40% and the wasted time 46% (waiting and unaccounted for constituting the balance), while under open observation their working time was 76.4% and the wasted time 13.8. He reported that a "fair estimate of the existing pay-roll waste would be not less than 65% of the labor pay-roll expenditures." Testimony subsequently taken before the Commission and before the Civil Service Commission confirmed the report of wholesale waste in the work of catch-basin cleaning.

An examination of the water-pumping stations, conducted by Mr. Dabney H. Maury, President of the American Water Works Association, revealed the existence of padded pay-rolls. After a thorough investigation of the water-works system he submitted a report on the whole situation, analyzing the conditions as he found them, and presenting constructive recommendations for enforcement of the service. His report showed enormous waste in the operation of the water-works as well as failure to reach proper standards of practical efficiency in service. On the pay-roll of the pumping stations, amounting to $397,862, Mr. Maury recommended reductions amounting to $75,760 according to one plan, and $171,242 according to another plan. He recommended changes in the equipment of the stations which would produce an annual saving of about $140,000; and changes in the purchase of castings which would save $38,082. With a modern type of hydrant he showed that it would also be possible to save about $40,000, the cost of annually packing our hydrants with manure for protection against frost.

Mr. Maury also called attention to the fact that in 1905 Chicago was obliged to pay $1,250,000 extra fire-insurance premiums on account of water-works deficiencies. His report also called attention to the enormous waste of water actually pumped. This amounts to about 66% of the total pumpage. It is estimated that 33% of the water pumped is lost before it reaches the consumer, and 33% is lost by leaky fixtures and otherwise after reaching the consumer. Mr. Maury also called attention to the wide discrepancy between the test duties of the engines at the pumping stations and the station duties as reported. With few exceptions these engines are all of types that should give test duties running from 100,000,000 to 180,000,000 ft.-lbs. for 1,000 lbs. of steam. The average station duty is below 79,000,000 ft.-lbs.

Examination of the Division of Bridges and Harbors by Mr. Walter H. Curtis showed similar results. His report states that the painting of bridge houses cost about five to seven times a reasonable price. Observations and estimates on other work done in this division showed a loss of about 50% in efficiency as measured by ordinary standards. As one of our investigators reported, referring to certain men "they expressed their opinion freely of the Commission, but that they did not care what was found in the report, as they were safe under their boss, who had instructed them to continue their work in their usual way, and not sweat blood." In the Harbor section of this division it was reported that half of the pay-roll expense could be eliminated, amounting to $7,640.

One of the most important reports submitted to the Commission was that made by Mr. Richard T. Fox on the Bureau of Streets. Our investigators were at first refused access to the Bureau records by the Acting Superintendent, but facilities for investigation were afforded later. One of the striking features of this report was the evidence of lack of standardization of work. For example, one street sweeper cleaned 10,970 sq. yds. of asphalt in good condition, with a horse traffic of 351 in 8 hrs. Another cleaned 15,190 sq. yds. in similar condition with a horse traffic of 699. Another sweeper cleaned 14,920 sq. yds. of brick in poor condition with a horse traffic of 1,406, while another cleaned 9,500 yds. in good condition with a horse traffic of only 495.

Investigation of street sweepers' work showed (after all necessary and reasonable allowances) a loss of 12% in time. This amounts to about $120,000 a year. Much of the time put in, however, was not properly employed. Investigators' reports show that 40% neglected their work to a very noticeable extent.

The time lost by the garbage teams observed was 22.5%, a loss to the city, as calculated by Mr. Fox, of about $70,000 a year. The ash teams lost in time 13.7%, or the equivalent of about $70,000 a year. These teams are one of the last big things left in the way of political patronage, and naturally it is difficult to secure economy under such conditions. Between June, 1907, and March, 1910, 71% of the teams in service were replaced, obviously for political reasons. Mr. Fox submitted detailed and important recommendations regarding the reorganization of the whole service.

In the Department of Electricity, the gas-lighting service maintained by the city was found to be in poor condition. Of 956 mantle gas lamps inspected, only 62% were in condition which could be called passable. The following table indicates the results found. It is highly probable that the light in case of mantle and open-flame lights could be increased 50% should the proper care (for which the city is paying) be given the lamps.

INSPECTION OF GAS LAMPS IN CHICAGO.

Good	173	20.2%
Fair	350	40.7%
Bad	229	26.7%
Very bad	82	9.69%
Out	24	2.8%
No chimney	62	7.2%
Broken glass	36	4.2%

The inquiry into the Building Department revealed the existence of serious disorganization and widespread demoralization of the service. The system of records was found to be incomplete; the inspection of buildings, elevators and fire escapes in many instances ineffective, the prosecution of violations of ordinances open to severe criticism. Of 147 suits filed during 13 months, only 7 convictions were secured; 38 cases

had been continued five or more times, and 121 cases continued from 1 to 13 times before final disposition. The Commissioner himself, when examined, "was unable to describe in even a general way the manner in which several of the important functions of this Department were administered," and showed an utter lack of familiarity with his Department. The Commission in its report declared that "the present Commissioner of Buildings is incompetent to longer hold his office."*

Reference has already been made to the inadequacy of the inspection service in connection with the enforcement of contract provisions. In all inspection services, whether the inspection deals with supplies and material, or enforcement of contract provisions as to method of performing work, the city is likely (as shown by our investigation) to receive less than full value for the money expended. The possibility of collusion with contractors, and in the absence of this the atmosphere of political influence, makes vigorous and effective inspection difficult. The diligent and impartial inspector is likely to make trouble for himself, and incurs a serious danger of removal or transfer, or he may fail to secure deserved promotion; or he may be subjected to the process of "making it unpleasant for him"—a step which is intended to get rid of the offender. It is clear that where a contractor is influential with the department or the administration, great pressure is brought to bear upon the inspector to relax his vigilance. The effect of this in the long run is to produce a demoralized condition in the entire service.

Investigation of the special-assessment accounting work of the city by Mr. Dickinson, President of Price, Waterhouse & Co., assisted by Mr. T. W. Betak, showed a considerable duplication of work. It appeared that men in the Board of Local Improvements, the Comptroller's office, and the Collector's office were carrying accounts which were in some instances copies, and which need not be done more than once under a proper system. It was estimated that some superfluous men were employed by the city for this purpose and that approximately $25,000 might be saved if the accounting system in these departments were recognized.

Civil Service System.

The Commission's inquiry also covered the practical operations of the merit system. This was one of the first inquiries made into the real workings of a municipal civil-service system, and developed facts of great importance not only to Chicago, but also to other cities operating under similar systems. This inquiry did not cover comprehensively such aspects of the operation of the systems as are not matters of record. In order to make the work complete, additional funds would have been necessary and investigators trained to do detective work. Even with these important limitations, the investigation was thorough enough to give a fair idea of the present workings of the system and to serve as a basis for recommendations as to changes.

In certain respects, important advances have been made recently in the workings of the merit system. This is particularly true of the system of re-grading positions in accordance with the duties of the respective offices. The effort of the recent civil-service commission to standardize the requirements of examinations, and also the methods of making the examinations, is distinctly creditable. The establishment of the efficiency division since the beginning of the Commission's investigation is an important step in the direction of high standards of public service.

In other important particulars, however, there was found to be room for immediate improvements. The present system of advertising civil-service examinations fails to provide for proper publicity, and thus limits the field of applicants, especially for the higher positions. There is a dearth of candidates for many important places, which can be accounted for by a general lack of information regarding the examinations. This is a serious restriction upon the merit system, and until some method of providing adequate publicity for these examinations is found the opportunities for public service remain practically unknown to the average citizen.

The practice of 60-day appointments is also a matter of very great importance. While many of these appointments are made for perfectly legitimate reasons, in other cases this does not seem to be true. To the extent that these preliminary appointments are made on a political basis, and for the purpose of providing information and experience to be used in a subsequent examination, it is clear that the purpose of the merit system is defeated. The conduct of the examinations for certain offices does not reflect credit on the Civil Service Commission, appointed and paid for the purpose of maintaining merit as distinguished from the political system. The most conspicuous case of this character is found in the selection of the City Statistician. The method in which certain positions in the Bureau of Engineering and the place of City Architect were filled is of the same general nature.

In the case of labor service, the case is distinctly discreditable to Chicago. The appointments in this division, instead of being on a merit basis, are (in the main) very plainly political. The observance of a number of forms in this connection by no means adds to the dignity of the Civil Service system of Chicago. It is extremely unfortunate that laborers should be led to present themselves at the Commission's office and sent to a physician's office for physical examination and, later (upon notification) go to the ward superintendent's office in search of a position, when, as a matter of fact, the appointment is determined by political recommendation. Day laborers ought not to be invited or permitted to spend their time and money searching for positions which it is wholly unlikely they will ever secure.

The fact is, that by various acts the Civil Service Commission created a general idea that appointment and promotion in the city service are not wholly based on the merits of the individual candidate, but depend to a very considerable extent upon political influence. The city employee is likely to get the idea that his best hope for advancement in the city's service lies in the strength of his political backing rather than the faithfulness and efficiency of his performance of his official duties. Whether or not this is wholly true, or applicable in a large percentage of cases, if the impression prevails that it is true, the effect is about as injurious to the city service as if it really were the case. This idea can be dispelled only by such unmistakeable action on the part of the Civil Service Commission as will make it absolutely clear that the Commission stands for the thoroughgoing application of the merit system in all cases.

Pension System.

A unique feature of our Commission's work was an inquiry into the city's pension system. The different pension plans were analyzed with a view to possible improvement in conditions. It was found that none of the funds has ever been carefully examined by an actuary, and all are more or less guess-work. The statutes governing the funds are defective in many particulars, notably in respect to refunds. In the case of firemen and policemen no refund whatever is provided. The administration of these funds by several boards is complex, cumbersome and expensive. Some form of consolidation would save time and money for the pensioners and the city.

An illustration of this was found in the case of the police pension fund. The Commission's inquiry showed that although this fund amounted to about $600,000, no interest was received from it. It was also found that an attorney for the Board was paid $5,000 a year for his services, although this work was formerly performed by the staff of the Corporation Counsel's office. The bond of the Treasurer was fixed at $40,000, and no outside audit of accounts was made by an independent firm.

The investigation for the Commission recommended the adoption by the city [illegible] superannuation system to cover all [illegible] present annual expenditure of [illegible] sion purposes is about $700,000 [illegible] tional cost is roughly estimated [illegible] on a contributary basis, about $[illegible] siderable number of men now [illegible] pay-rolls are in effect "pensioned" [illegible] persons who have long been in [illegible] are wholly or partly incapacitated [illegible] performance of their duties, but [illegible] full pay. Their retirement on [illegible] have strengthened the service [illegible] cided economy for the city.

Entirely aside from the humanitarian considerations involved, it would improve the efficiency of the service if a pension were made to cover all employees. The practice of large private corporations indicates that business motives alone justify the adoption of the pension system. Such plans have already been put into practical effect by London, Paris, Berlin, and other large municipalities, and it can only be a question of time until the same step is taken by Chicago.

Results of the Work of the Commission.

The results accomplished by the work of the Commission were substantial and important, although short of what might have been obtained with proper backing.

The new segregated budget system which was adopted gave the city more complete control over expenditures and in this way made possible great economies, especially in connection with the other work of the Commission. The public were relieved from the payment of about $10,000 a year in fees to the City Clerk. The police pension fund was reorganized and interest amounting to about $25,000 a year was added to the fund, while a suit for payment of back interest was instituted. During the investigation the pay-roll of the water pumping stations was reduced to the extent of $35,000, a new engineer was placed in charge of the stations, and an effort made to reorganize the system.

As a result of the Commission's recommendation, the Commissioner of Public Works and the Deputy Commissioner resigned and were replaced by more efficient men. The Superintendent of Sewers was discharged by the Civil Service Commission and his place filled by a more capable man. The Superintendent of Dumps was discharged by the Civil Service Commission. The recommendations of the Commission in respect to the City Purchasing Agent and the Commissioner of Buildings were, however, wholly ineffective. The amount of work done in the various departments materially increased under the stimulus of the inquiry. This was particularly noticeable in the Department of Public Works, where the greatest wastes were found, and where there was consequently the greatest opportunity for improvement.

The improvement in city contracts was general. Old specifications were reconsidered and revised, and their enforcement somewhat more carefully looked after. A noticeable instance of this was the coal contracts, which were brought up to date. Purchase was made on the B. T. U. plan,* and the enforcement of specifications was carefully guarded. The enormous frauds and waste in connection with the purchase of coal were checked and large sums saved to the city. The price of castings was cut, resulting in an annual saving of $25,000 on this item alone. Hay and grain specifications were revised and placed upon a different basis. In the Fire Department competition has been introduced for the first time in 20 years, and the quality of the materials delivered was substantially improved. The system of purchasing hose in the same Department was also revised to conform to the specifications suggested by the National Board of Fire Underwriters.

The gasoline lighting contract in the Department of Electricity was revised and more attention given to inspection; with the result that (for a time at least) lights were kept up to the stand-

*He has been displaced and a new incumbent appointed by the present administration.

*Engineering News, Nov. 24, 1910.

ard set by the contract. Under the stimulus of the investigation the contract with the Drainage Board for use of its electric power for lighting purposes (which contract had been mysteriously lagging for several years) was suddenly completed. This arrangement will add 10,000 new lights to the city's equipment at a cost of only 20% more than is now paid for over 12,000 lights. The transfer of the 39th St., Lawrence Ave., and Wilmette pumping stations to the Sanitary District is another illustration of the same tendency to activity under the influence of the Commission inquiry.

Paving specifications were revised by the Board of Local Improvements to some extent, although by no means to the degree recommended by Mr. Whinery. An additional force of inspectors was added to the staff of the Board of Local Improvements, with a view of securing more faithful performance of contract obligations. It is doubtful, however, whether this additional number very materially improved the situation. Although business methods of the Police Department were found in better condition than anywhere else, Chief Steward made a vigorous and successful effort to improve the system still further.

As a result of the frauds disclosed in purchase of coal, the auditing of bills was transferred to the Comptroller's office, and provision made for central audit in that department. This will, at any rate, prevent the careless kind of an audit made by the retired officers in the Fire Department, and should ensure more careful and expert scrutiny of bills against the city.

After the Commission began an inquiry into the rates of interest received by the city upon the public funds, the Comptroller discovered that he could secure ¼ to ½% more in the way of interest than he had previously received. The rate was raised from 2% to an average of 2¼%, thus increasing the revenue of the city by about $50,000 a year. A bill authorizing the investment of city funds in anticipation of tax warrants was also prepared and has just been passed. This will make possible an annual saving of about $200,000. An indirect result of the activity of the Commission was the establishment of the Efficiency Division in the Civil Service Commission. This bureau was organized for the purpose of studying conditions in the several departments, and of making suggestions for improvement. If this work were carefully and impartially conducted and adequately supported, it would effect important changes in the city service.

On the other hand, important changes suggested by the Commission were not made, as they could have been with the sincere and earnest cooperation of the administration in our work. After demoralized conditions were disclosed in the City Purchasing Agent's office, the head of the department was permitted to remain undisturbed. In spite of the deplorable and dangerous conditions revealed in the Department of Buildings, the head of that department was not relieved of his grave responsibilities. (He has been replaced by a new man under the present administration.—Ed.) Had the recommendations of the Commission been vigorously taken up by the city and an aggressive policy pursued, much more sweeping changes might have been made, to the great benefit of the taxpayer and the public. In individual cases where such cooperation was secured, progress made was rapid and marked. Among the more important of the Commission's recommendations not yet carried out are the following:

(1) Establishment of a central purchasing agency and reorganization of methods in that bureau.

(2) Reorganization of special assessment accounting, with a view of eliminating duplicate sets of accounts and clerks.

(3) Reorganization of the Bureau of Streets as recommended by Mr. Fox, with special reference to the elimination of ward lines and to securing more effective supervision of the work.

(4) Reduction of the pay-roll in the various pumping stations and other important changes in the organization and methods of the water system, as recommended by Mr. Maury.

(5) Reorganization of the Building Department and introduction of more energetic and business-like methods into that branch of city government.

(6) Reorganization of work and reduction of the pay-roll in the division of bridges and harbor.

(7) Revision of paving specifications, recommended by Mr. Whinery, especially with reference to wood block monopoly and the adaptation of thickness of pavement to traffic on the street. Also recommendations in respect to securing greater efficiency in the inspection of pavements laid.

(8) Recommendations in regard to the work of the Civil Service Commission with reference to publicity regarding vacancies in the service, elimination of 60-day political appointments, and reorganization of the labor division.

When the 1911 budget was presented to the Council, I presented amendments which would have reduced the pay-roll obligations of the city about $100,000 per year. These were voted down, however, and the superfluous positions were continued at the expense of the public.

Over criminal prosecution the Commission had no control. The Commission had no power to compel the attendance and testimony of witnesses, excepting city employees; or to compel the production of books, documents, and papers, other than those of the city. The Commission had no power to prosecute any one, or to begin a civil suit. It was purely an advisory body, entirely dependent upon the city and the county for the execution of its recommendations. All of the Commission's material was given promptly to the State Attorney for Cook County. A stenographic copy of all hearings was sent to that officer. At many of the hearings a representative of the State Attorney was present, at my request, and all evidence or clues that might in any way assist the course of criminal justice were presented. The chairman and the attorney for the Commission consulted with the State Attorney, our investigations were used before the Grand Jury, and otherwise no step left untried to bring the guilty to punishment.

From the observations made in the various bureaus and departments, it is clear that a great gain could be made in most classes of city expenditures under proper management. With a properly selected purchasing department, careful attention to the letting of contracts and their enforcement, and with careful organization and supervision of the working force of the city, very material economy could be effected.

The three great sources of loss are outright graft or stealing, political favoritism, and lack of proper system. The dividing line between these three is not always clearly marked and they very often shade into each other. It is an easy step from a lax system to political favoritism, and it is an easy step from political favoritism to plain graft. Lack of system fosters political favoritism and graft, and at the same time political favoritism stands in the way of proper methods of organization and supervision. We may say that if graft and politics were eliminated the introduction of business methods would be comparatively easy; and on the other hand we may say that with a proper type of system, both political favoritism and theft would be made more difficult. Eliminate these three great types of waste, establish the principle of absolute integrity and public efficiency, drive out politics from the administrative departments, emphasize the importance of economy and efficiency, and the taxpayer's dollar would go much farther than it now does.

An important problem barely started by the Commission was that of departmental reorganization. At present the number of departments is so great, and their work so badly organized that the resulting loss in economy and efficiency is great. As things now stand, there are more independent heads of departments in Chicago than there are in the government of the United States. A simpler form of organization could undoubtedly be worked out to the very great advantage of the administration and the city. One of the chief advantages of the commission form of government has been the definiteness with which power and responsibility may be located. So far as the administration is concerned, many of these advantages might be gained by simplifying the organization of the several bureaus and departments and by more careful coordination of their work.

The establishment of the Bureau of Public Efficiency* under the auspices of the City Club is a guarantee that work of this character will be continued and extended to include the other local governing bodies of Chicago and Cook County. The complexity of our local political system makes the existence of such an agency all the more necessary.

The Chicago Bureau of Public Efficiency.

In 1909, an official investigation into the administration and work of various departments of the city government of Chicago was undertaken by a commission appointed by the city, and known as the Commission on City Expenditures. The work of this commission is described elsewhere in this issue by its originator, Prof. Charles E. Merriam. Following the investigations, disclosures and suggestions made by the commission, and in view of the approaching termination of its work, the City Club of Chicago proposed the organization of a Bureau of Public Efficiency, somewhat along the lines of the New York Bureau of Municipal Research. The proposition was well received by business men and the public, and the bureau was organized in 1910. Many of those active in its formation were prominent in the work of the commission also. The bureau, however, does not limit its activities to the city government, as did the Merriam Commission, but aims to cover all the local governing bodies in the community. Its general object is to aid in the establishment of sound business principles in the local government of the city, and the following is the statement of its purposes:

(1) To scrutinize the systems of accounting in the eight local governments of Chicago.

(2) To examine the methods of purchasing materials and supplies and letting and executing construction contracts in these bodies.

(3) To examine the payrolls of these local governing bodies with a view of determining the efficiency of such expenditures.

(4) To make constructive suggestions for improvements in the directions indicated under the foregoing, and to cooperate with public officials in the installation of these improved methods.

(5) To furnish the public with exact information regarding public revenues and expenditures, and thereby promote efficiency and economy in the public service.

Its work so far has included investigations of five specific subjects: (1) the work on the new City Hall; (2) the methods of preparing and administering the budget of Cook County; (3) the proposed purchase of voting machines by the Board of Election Commissioners; (4) street paving materials and workmanship; (5) electrolytic corrosion of water pipes. The reports on the last four matters have been issued in pamphlet form, and those relating to paving and electrolysis are of particular interest to engineers and municipal officers.

The officers of the bureau are as follows: President, Julius Rosenwald; Trustees, Onward Bates, M. Am. Soc. C. E., Clyde M. Carr, George C. Tunell, Charles R. Crane, H. B. Favill and Walter L. Fisher; Director, Herbert R. Sands; Chief Engineer, Alonzo J. Hammond, M. Am. Soc. C. E.; Secretary, George C. Sikes.

Cold Storage and Refrigerating Warehouses in New York State have been placed under the jurisdiction of the State Commissioner of Health by an Act recently passed by the Legislature. Besides giving the power of inspection and supervision, the Act also limits the period of storage of any kind of food to 10 months, except that butter may be kept in cold storage for 12 months.

*This is dealt with elsewhere in this issue.—Ed.

A Swiss Transformer Station and Distributing Tower.

By J. B. VAN BRUSSEL.*

The well-known Swiss company, the Oerlikon Works, have recently begun building a type of combined local transformer station and tower for radiating service lines. Such station towers have a number of advantages over separate structures which have been erected in the past to serve the same ends. On account of small ground-space requirements, these towers can be erected almost anywhere—even in the midst of other buildings. Aside from a considerable reduction in the first cost of such stations and the possibility of moving the station if desired, they may be completely fitted at the central-station shops, except for the heavy transformer, and put into service after connecting the transformer and the primary and secondary conductors to the proper lines.

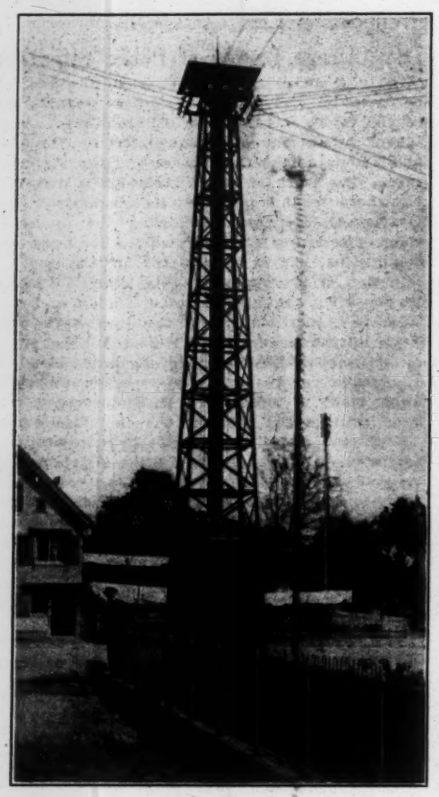


Fig. 1. A Swiss Transformer Station and Distributing Tower.

As shown in the accompanying figures, the towers are made of steel framework rising from a cabin receiving the transformer and switching apparatus. The lattice work may be made not unpleasing to the eye, and by proper painting may even be more or less adapted to the appearance of the surroundings.

The cabin affords ample room for especially clean and safe arrangements of all apparatus and conductors. It is generally fitted with two operating doors, for the purpose of controlling the high and low-tension ends respectively, but can be made accessible from all four sides. A galvanized sheet-iron tube 11.8 to 23.6 ins. in diameter is used for leading the primary conductors down into the cabin. At each of its ends a cast-iron spider is fitted in its interior, carrying the tightening devices for three or six bare copper wires. The sheet-iron tube below the upper roof of the tower rises to a height sufficient to prevent any rain from penetrating into its interior. The secondary conductors are led out of the cabin through porcelain tubes protected against rain by a special roof. These conductors go up the outside of the sheet-iron tube and are also bare.

*P. O. Box 151, Brussels, Belgium.

The admission of fresh air is effected through apertures in the foundation, a good ventilation of the transformer being insured by the draught of the admission tube. These apertures are arranged in the top part of the foundation, immediately below the iron foot of the tower. Another arrangement has also been used which, though somewhat more expensive, is considerably better, excluding as it does the entering of possible splash into the interior of the cabin. It comprises an aperture on one side of the foundation closed with a perforated plate, through which a supply of fresh air is allowed to penetrate directly into the cabin below the transformer.

These tower stations under consideration are designed in three sizes, the space available for the transformer having the following dimensions:

Size:	Length.	Height.	Width.
A	3.28 ft.	4.92 ft.	2.30 ft.
B	3.94 ft.	4.92 ft.	2.95 ft.
C	4.26 ft.	4.92 ft.	3.28 ft.

Fig. 2. High-tension Compartment of Transformer Cabin; Oerlikon Tower.

The largest size suffices for the installation of a transformer of very considerable capacity. In case it is desired to put up two transformers, the secondary bus-bars are provided with switches and connections, allowing the transformers to be worked separately or in parallel.

Interstate and Municipal Utilities have been taken up for study by the National Civic Federation, whose headquarters are in New York City. A Department on Regulation of Interstate and Municipal Utilities has been created and recently the Sub-Committee on Plan and Scope submitted a report discussing the possible work of the committee and suggesting sub-committees on:

Regulation of Rates.
Control of Service.
Control of Accounts and Reports.
Regulation of Financial Matters.
Conflicts of Jurisdiction.
Control over Labor Questions.
Legal and Legislative.
Committee on Ways and Means.

Among the members of the Committee on Plan and Scope are Messrs. Emerson McMillin, 40 Wall St., New York City, and Milo R. Maltbie, one of the members of the Public Service Commission, First District, New York City.

Surface Tarring of Macadamized [illegible]ghways.*

By. DR. GUGLIELMINET[illegible]

It was about ten years ago th[illegible] made at Monaco, and published an account [illegible] first experiments in road tarring. The r[illegible] of these attempts have since been checked [illegible] experts of almost every nation who discusse[illegible]m at the International Road Congress in P[illegible] 1908) and Brussels (1910). At the Brussels [illegible]ss it was formally acknowledged that the s[illegible]e tarring of roads may now be considered [illegible]ying definitely entered the region of prac[illegible]

Economic Results.

It is proved, then, that the hyg[illegible] object of tarring—that is to say, the consid[illegible]ble diminution of dust—is actually attained. From the economic point of view, however, we have still to ascertain if tarring is a very costly process or not. All engineers are agreed that tarring lessens the wear and tear of the highway and increases its durability, to say nothing of the considerable reduction in cost of cleaning (watering, scraping, sweeping). Up to now, however, it has been rather difficult to express in figures the saving effected by tarring a given roadway. Some time, in fact, is required to enable a judgment to be formed concerning economic results from the point of view of the maintenance of a highway, the nature and frequency of the traffic over which may vary considerably from one year to another. But there is in Paris a thoroughfare which has been tarred for the last five years, and the nature of the traffic over which does not vary, because heavy vehicles are forbidden there; so that there is only the frequency or amount of the traffic to be considered, and this, indeed, increases every year. The thoroughfare in question is the Avenue du Bois de Boulogne, and, thanks to the information furnished by Monsieur Bret, Chief Engineer of Roads and Bridges for the town of Paris, we are now in a position to give the exact figures of the economic results obtained by tarring this thoroughfare.

One of the most beautiful thoroughfares in the whole world, it descends in a gentle slope from the Place de l'Etoile as far as the Porte Dauphine at the entrance of the Bois de Boulogne. Its length is 1½ km. (0.93 mile), and its breadth is 16 m. (52½ ft.). It is bordered on one side by a riding track for equestrians, and on the other by a wide pavement for foot passengers. The surface of the road measures 23,580 sq. m. (28,101,680 sq. yds.).

After having been relaid in September, 1906, this thoroughfare was tarred by Lassailly for the first time in the month of May, 1907. Since then the road has not been relaid, whereas before it was tarred it had to be relaid every three years.

The expense before tarring was adopted had been as follows:

	Francs.
1903—Relaying in March	112,779
1904—Maintenance repairs	26,481
1905—Maintenance repairs	32,657
1906—Maintenance repairs (before the relaying in September	1,218
Total	173,135

or, on the average 1s. 5d (34 cts.) per sq. yd. per year.

Since tarring was adopted the expenses have been as follows:

		Francs.
1906—Relaying in September		97,482
1907— Maintenance repairs 2,977 francs Tarring in May....3,860 "		6,837
1908— Maintenance repairs 9.151 " Tarring in April....5,939 " Tarring in Sept....3,146 "		17,836‡
1909— Maintenance repairs 12.998 " Tarring in April... 4,716 " Tarring in Sept... 4,542 "		22,256
1910— Maintenance repairs 6.635 " Tarring in April... 5,395 " Tarring in Sept... 4,528 "		16,558
Total		160,969

or, up to March last, 1s. (24.3 cts.) per sq. yd. per year.

The saving effected up to now is therefore, about 25% on the cost of relaying and maintenance alone, not to mention the saving effected in expenses for cleaning.

We have seen that the road was only tarred once during the year 1907, and twice a year—in spring and autumn—commencing with 1908. We had requested the town of Paris to make that

*An article specially translated for "The Surveyor" (London), which appeared in that journal for July 28, 1911.

†Paris, France.

‡Translator's Note.—There is a slight arithmetical error here, as the sum of these three items for 1908 should be 18,236 francs. The difference of 400 francs does not, however, seriously affect the argument.

first trial experiment in the autumn, so that the road might begin the winter season with its coating of tar intact. The result was so striking that in the spring the surface was still in a state of quite excellent preservation, the tar having in great part remained on the road. It was only in the middle of the roadway where the traffic is heaviest that the tar covering had a tendency to disappear in the springtime.

As far as this avenue is concerned, therefore, the economic question is settled, and we may say that the life of the roadway is certainly doubled, so that the cost of tarring is more than recouped by the extension of the period of duration, as is proved by the figures given above. Moreover, the frequent relayings—lasting nearly two months each time—constituted a serious inconvenience to traffic, while the interruption to traffic necessitated by tarring lasts no longer than the few days required for the tar to dry.

With regard to the suppression of dust, the result is marvellous. Where on sunny days we could never successfully cope with the dust, in spite of waterings repeated every two or three hours, one washing a day has proved amply sufficient since tarring was adopted, and no one complains of dust. We may remark here, moreover, that in this avenue, where the daily traffic includes some 40,000 motor cars, frequent waterings became almost impossible, so that in the evening, when the motors returned from their outing, the clouds of dust raised behind the vehicles spoilt all pleasure for the foot passengers, and completely ruined the hats and dresses of the ladies. Before tarring was adopted it was impossible to maintain this road in a serviceable condition. Since tarring has been adopted, the same road has excited the admiration not only of those who use it, but also of engineers from all countries.

But because tarring has produced from every point of view, good results in the Avenue du Bois de Boulogne, must we therefore conclude that it will yield the same good results on all macadamizer roads? It would be rash to assert this, for on this road, well exposed to the air and the sun, the traffic is exclusively a traffic de luxe, very crowded, yet not of a heavy character, the big, heavy vehicle being forbidden there.

It is evident that the selection of the roads to be tarred is an important factor in estimating the economic results, and it is a question not only of knowing when and how we must use tar, but also which are the roads that may be tarred with success; and this may enable us to account for the misunderstanding between the engineers of town streets and the engineers of country roads at the Brussels Congress.

The former, considering that town traffic tends to become more and more crowded and heavy, boldly advocated the suppression of macadamized roads, and their replacement in every case by roads paved with stone, wood or asphalt. When they invited the Congress to condemn macadam in towns, the engineers of country roads—English, American, Belgian, French, etc.—protested as one man, insisting on the good results obtained by the surface tarring of macadamized roads which, in their opinion, might—in certain towns where the traffic is not very heavy—perfectly well replace the paved roads.

It is evident that different kinds of traffic require different coatings for the roadway, and the ill-success attributed to tarring frequently arises from the bad choice of the road tarred. It would be absurd to tar a macadamized road which, from the nature and frequency of the traffic, is obliged to be relaid every two years, or even every year. Such a road should be paved, and it is useless to attempt to prolong its life by tarring. Tarring can only yield good, economic results on a macadamized road, which, by reason of the nature and frequency of its traffic, may remain macadamized—that is to say, which only requires relaying every three years, or even less frequently.

Effect of Tar Upon Vegetation.

It was on account of the good results obtained—both from the point of view of dust suppression and from that of road preservation—that the Second International Road Congress (Brussels, 1910) declared that surface tarring had finally entered the region of practice.

Nevertheless, as nothing is perfect in this world, the surface tarring of roads does present some inconveniences, and appears to have an injurious effect on the eyes of those who use the road, and on the plants by the wayside. Is the remedy for the dust nuisance, then, worse than the nuisance itself?

With regard to inflammation of the eyes being due to tar dust, we are still waiting for proofs. Neither in the Avenue du Bois de Boulogne, nor on the road from Paris to Versailles, which is tarred throughout its entire length, have any serious complaints of this kind been preferred. I live in the Avenue du Bois de Boulogne myself, and walk or drive there every day, but I have never heard the least complaint on this subject.

The towns of Cannes, Nice, Mentone and the Route Nationale between Cannes and Mentone have been tarred every year for the last eight or nine years, and there have been no complaints. Yet, if there is a district in which the eyes suffer from refraction of light and from dust, it is certainly that same Cote d'Azur, where, between Nice and Monte Carlo, for example, there is an average daily circulation of 1,100 motors during the season.

In order to try and prove the injurious effect of tar dust on the eyes, scientists have rubbed the eyes of rabbits and other animals with tar dust, and this has caused conjunctivitis. There is absolutely nothing astonishing in that. Everybody knows that tar is not a remedy for the eyes, and that conjunctivitis may be produced by dust that is free from tar. Those laboratory experiments have, therefore—as is admitted by the experimenters themselves—no practical bearing on road tarring.

With regard to the pernicious effect of tarring upon the trees and flowers of promenades, opinions are divided into two camps: on the one side the horticulturists defending their plants, and on the other the road engineers defending the tar. Nevertheless, these two camps are not so much opposed to each other as one might think at first. The superintendent (conservateur) of the Bois de Boulogne himself, in spite of his anxiety on the subject of the evil influence of the tar on his plants, admits that he cannot do without the tarring. He has recognized the necessity of tarring the principal avenues of the Bois, which were becoming impossible resorts for pedestrians and horse-riders since the introduction of motor cars. On the other hand, the road engineers, who do not see the possibility of giving up tarring at present, quite understand that the beauty of the Avenue du Bois de Boulogne and of the Bois de Boulogne itself consists precisely in the vegetation, in those magnificent trees which line the avenues, and which it is absolutely essential to try and preserve.

With regard to the roadway of the Avenue du Bois, indeed, a coating of greater resistance than macadam—wood paving, for instance—would deprive it of its rural character, and if it were once thought necessary to abandon macadam, it would appear to be impossible to maintain this roadway in a practicable condition without tarring. This avenue, which before tarring was "a skimmer between two successive relayings," is now the admiration not only of those who habitually use it, but also of engineers from every country. With the tarring, moreover, a yearly saving of about 15,000 fr. is effected.

Monsieur Griffon, as a true plant-doctor, said in his communication to the Academy, Dec. 5, 1910, that we must distinguish between two different causes of injury to plants—(1) tar vapors or fumes, and (2) tar-laden dust.

With regard to the vapors, it has been known for a long time past that the fumes given off by hot tar kill the cellules of vegetable tissues under laboratory experimental conditions. But rash would be the expert who should draw a conclusion from these laboratory data only.

The border plants are not in an enclosed space; the tar, being spread in a thin layer, cools rapidly and the fumes which it gives off are diluted by an enormous volume of air.

Moreover, the tarring operations which I have followed at Paris in different thoroughfares prove that during the period of spreading and afterwards, until the circulation of vehicles has taken place, the action of the tar has really been of no account whatever—non-existent (nulle).

With regard to tar-laden dust, I have ascertained that this dust when spread on leaves of certain plants of very aqueous and delicate tissues (begonias, pelargoniums, saxifrages) produces burns, while with ordinary road dust no injurious action has declared itself. On the other hand, under the same conditions, numerous ornamental herbaceous species, plants of high culture, trees and shrubs, have presented no symptom of disease.

My experiments explaining the withering of certain plants could not therefore, account for the darkening of the leaves of chestnut trees and other trees in certain thoroughfares. We know that the age of the trees, their individual condition, and, above all, the special conditions under which the roots live in urban centers—all these factors, as has been clearly demonstrated by Monsieur Mangin, play a most important part.

If I add to all the foregoing that I have seen quite lately, in places quite remote from tar, leaves presenting exactly the same burn stains as I had attributed last year to tarry dust, and that my personal investigations made at Paris, in the suburbs, in England, and in the South of France are, so to speak, entirely favorable to tarring, and that even in the Avenue du Bois many herbaceous or woody species are uninjured, it will be acknowledged that it would be very unjust to throw the blame on a process which offers real advantages from the point of view of dust diminution and proper maintenance of roads.

In special cases this process may, of course, have some disadvantages; but, before prescribing it, experiments should be made under practical conditions.

Nowhere abroad [outside France] have similar complaints made themselves heard. It is noteworthy that in England—where surface tarring has greatly increased, 1,866 miles of road were tarred in 1908, and 9,330 miles in 1910)—a technical paper, "The Surveyor," invited information on the subject from engineers, and received no serious complaint from the point of view of the disastrous effect of tar on the eyes and on plants.

In like manner, a German paper, "Der Strassenbau," instituted a similar inquiry, with the same negative results.

Nor have there been any complaints in Belgium where tarring has finally entered the region of practice; and it is a curious circumstance that in the South of France, at Nice and Mentone, where, thanks to the Anti-Dust League, the funds of the association are doubled by the State for the tarring of the national roads (50,000 fr. are spent annually on tarring)—no one complains of the tarring. The owners of the pretty villas whose gardens border on the roads are the best subscribers to our league, and the Eastern Society of Horticulturists at Cannes has formally notified me that it has received no complaint on the subject of the injurious effect of tar on vegetation.

These statements, which appear to be contradictory, are not so in reality, since it is a question of plants of essentially different kinds. In fact, the plants of the South have a much higher power of resistance than those of our districts, and this would be a good reason for trying to change the kinds along the tarred roads of the Bois du Boulogne. On the other hand, the great country roads abroad, and even those in France, cannot be compared, from the point of view of aeration, situation and traffic, with the Avenue and the various vistas of the Bois du Boulogne with which we are here specially concerned.

In order to be able to elucidate the problem, it would be necessary to make experiments which should be very exact, and which should be carried out under identical conditions of exposure, and of traffic on tarred roads and on roads not tarred. To this end the Prefect of the Seine has appointed a commission to examine the question and to seek, if there is occasion to do so, the means of guarding against that drawback [of injury to vegetation caused by road tarring]. This commission, of which I have the honor to be a member, is composed of several members of the institute [Government departmental heads and others, including engineers, horticulturalists, a chemist and vegetable pathologist—Ed. Eng. News] and several engineers and horticulturists of the town of Paris.

This commission will plant clumps, composed of different plants, along the Avenue du Bois, which is tarred, and on untarred thoroughfares presenting about the same conditions of exposure and traffic. At the same time exact laboratory researches will be made on the subject of the spots or stains that have been noticed on leaves of trees.

It is to be hoped that as a result of these experiments more precise data will be obtained as to the effect on plants of the tar now used. What may be affirmed at present is that the tar has a certain effect on vegetation; it is to be added, therefore, to the numerous causes of tree-decay already existing in towns (gas, electricity, want of air, reflections from walls and pavements, and so forth).

In the meantime researches are being made with a view to eliminate from coal tar any substances that might be injurious to plants, and Monsieur Lassailly has already succeeded in determining a formula of composition approximating more nearly to that of a tar entirely innocuous to plants than to that of coal tar. We have still to learn if this new tar is as efficacious from the road point of view, and if its net cost is such as to bring it within practical reach.

General Considerations.

Here, then, in effect, is the present position of the question. There is no cause for immediate alarm, and it must be hoped that road tarring, which at present is solving in a practical fashion the problem of the adaptation of roads to automobiling, will not present any such disadvantages as shall necessitate its abandonment. If, however, it were as deserving of condemnation as is alleged, it seems to me that, on the one hand, ornamental plants of a higher resisting power might be used along the roads, and, on

the other hand, that injurious substances might be eliminated from the tar.

The important matter for the moment is to try and suppress tarry dust. It is a serious mistake to believe that a dustless road will be obtained merely by having it tarred. Tarring does, indeed suppress almost entirely the dust arising from the wear and tear of the roadway, but it affords no protection against the imported dust brought thither by the wind or by the traffic. It is this latter which must be strenuously combated by waterings more or less frequent according to the weather and the intensity of the traffic.

We have suggested that in Paris a trial should be made of mixing with the water used on tarred roads some oils soluble in water—such as "Westrumite"—for I am still convinced that a mixed fluid of this kind will lay the dust better than water alone will do. By completely suppressing the dust on tarred roads every subject of complaint in relation to the injurious effect of tarry dust on vegetation will be avoided, while awaiting the final solution of this question.

To sum up, it may be affirmed that the surface tarring of macadamized roads, well carried out, and on roadways which from their nature and the intensity of the traffic can remain macadamized, is not only the best remedy against dust from the hygienic point of view, but also from the economic point of view, since in this Avenue du Bois de Boulogne in Paris it realizes an annual saving of 15,000 fr. If the proximity of vegetation must—though I do not think it must—forbid the extension of this process to thoroughfares bordered with trees and delicate flowers, there remain to be tarred enough roads that have neither flowers nor trees, or that are bordered with ornamental plants of a hardier kind.

We must hope, therefore, that France, the cradle of surface tarring, will not allow itself to be too far surpassed by other countries, such as England, for instance, which in 1910 tarred more than 15,000 km. (9,330 miles) of roads, representing the fine total area of 80,000,000 sq. ms. (95,682,400 sq. yds.).

The Operation of the Milwaukee Incinerator; A Study in Efficiency Engineering.

Since the refuse incinerator of the city of Milwaukee (Eng. News, July 21, 1910) was put in service on May 12, 1910, its operation and problems have been studied by the Milwaukee Bureau of Economy and Efficiency. This work of the Bureau is outlined in a report recently submitted to the Commissioner of Public Works and the Finance Committee of the Common Council, and from that report the following information has been selected as being most valuable and interesting. There has been hearty cooperation between the Bureau and the various public-works officials and, as a result, savings of $16,200 per year have been made already and the possibility of $47,800 more has been pointed out.

It will be recalled that this incinerator is a four-unit plant of the Heenan and Froude (British) type, having a total capacity of 300 tons per day. There are two main floors and a basement, the upper floor being used for storage and charging, the main floor for furnaces, boilers, etc., and the basement for handling the final clinker. All sorts of refuse is handled, the garbage being delivered separate from ashes and rubbish. As the plant is being run primarily to dispose of the garbage, only enough ashes and rubbish are delivered at the incinerator to yield a proper mixture for easy combustion.

Prior to January, 1911, garbage was collected by the Department of Health, and ashes and rubbish by the Department of Public Works. By suggestion of the Bureau of Economy and Efficiency, the collection of all classes of refuse has been taken over by the Department of Public Works, with savings in cost of collecting and burning. The garbage is now collected on five days instead of six, except in summer, the average load per collection being increased. This saving amounts to $8,550 per year. There is also a chance for shutting down one or two furnaces at the incinerator on non-delivering days for cleaning and opportunity to better clean up the refuse bins.

At first a mixture of 50% garbage with 50% ashes and rubbish was fired, but it was found possible to push the percentage of garbage to 63.5. Present practice aims to fire a mixture containing 60% garbage—the records showing 57+% since Jan. 21, 1911. The annual saving by this change, due to reducing the total material fired and the number of furnace shifts, is estimated at $4,298. The Superintendent, Mr. S. A. Greeley, Jun. Am. Soc. C. E., has initiated the practice of picking out bottles, cans, paper, etc., which has yielded income at the minimum rate of $400 per year, without added labor, or interfering with the efficiency of floormen, or danger to health.

A thorough engineering study of the plant was made by Messrs. L. E. Reber, M. Am. Soc. C. E., and E. B. Norris, of the University of Wisconsin. As a result, it was recommended that only one floorman (refuse handler) should be allowed to a furnace during the day, with extra laborers on the afternoon and night shifts. This recommendation has already been put into effect, reducing the number of floormen from 16 to 13 per day—with the present average of 2⅔ furnaces operated per day. With all three furnaces in daily operation the labor required would be 14 instead of 18 floormen. This has given a reduction of $1,872 in annual expense. It was also recommended that five firemen should be allowed to two furnaces, the odd man working alternately on each furnace. This would reduce the number of firemen.

A new type of rubbish wagon box was recommended, to enable a reduction of the cranemen's helpers from three to two per day.

The Superintendent of the incinerator, it is proposed, should transfer his headquarters to the City Engineer's office, where he may make his technical knowledge of waste disposals of greater service to the city.

The most important recommendation, however, relates to the utilization of the steam generated in the incinerator boilers. With a mixture of 60% garbage, a minimum of 13,500 lbs. of steam per hour is available and this is entered in the list of possible revenue producers at the cost of steam produced with coal—4 cts. per 100 lbs. delivered to turbines or engines. The annual net profit would be $36,576.

It is proposed to install a crusher and sell the clinker from the refuse furnaces as aggregate for concrete, a price of 75 cts. per cu. yd. being possible. This would bring in $7,020 per year. The combustion-chamber dust has been analyzed and found well adapted for use as an asphalt filler. By using the empty refuse teams to haul the dust to the asphalt plants, to reduce the cost of delivery, an annual income of $1,147 is expected.

The Bureau of Economy and Efficiency has studied the costs of operation for the three months ending March 31, 1911, and has established comparative figures known as "theoretical" and "standard" shown in the accompanying table. The former are based on evident conditions of operation identical with those from which the actual costs are figured and the difference existing shows additional labor or charging truly indirect expense as direct. The standard costs are based on minimum use of furnaces with maximum charges of 60% garbage mixture operated by minimum possible crew. These last figures represent minimum p[illegible] cost of operating the plant solely to in[illegible]te garbage (as distinguished from possible [illegible]er generation). To establish such true c[illegible] was considered necessary to include s[illegible]ms as repairs, maintenance, replacem[illegible]preciation, insurance, rental, taxes, etc., [illegible] would be computed for a private concer[illegible]er than are they have actually been asses[illegible]n the city. For instance, there is no insur[illegible]other than on the boilers, and the figur[illegible]ooted cover charges on full value of origin[illegible]t of buildings and machinery less founda[illegible] and annual depreciation; employers' liability [illegible]s also been covered. The local taxes are [illegible]ly exempted and there is no rental, but a ch[illegible]e of 5% per annum on land and plant, plus t[illegible]es, has been computed. Having done this, the interest on bonds and state taxes, which are really paid, are not entered here.

Estimates of depreciation were based on experience with other machinery elsewhere. No allowance was made for scrap value, since some parts would not only have no such value but would entail expense in removal. Excavation, piling, concrete, steel in concrete, chimney, engineer's fees and superstructure are given a life of 50 years; hoppers and parts of buildings subject to wear have been allotted 30 years; furnaces have 20 years; boilers, settings, piping, forced-draft plant, charging devices, cranes, engines and generators have 15 years; clinker cars, tools and instruments have only five years. The approximate composite life is 20[illegible] years and the rate is 5%.

TOTAL COST PER TON OF GARBAGE FOR THREE MONTHS ENDED MARCH 31, 1911.

1911.	Direct furnace labor.	Indirect labor.	Plant expense.	Maintenance.	Insurance.	Interest rental taxes.	Depreciation	Total.
JANUARY.								
Actual	$1.435	$0.5237	$0.0216	$0.1400	$0.0271	$0.5466	$0.3829	$3.0769
Theoretical	1.351	.539	.0216	.1400	.0271	.5466	.3829	3.0082
Standard	.9152	.367	.0172	.1110	.0215	.4331	.3033	2.1683
FEBRUARY.								
Actual	$1.2390	$0.5120	$0.0218	$0.1411	$0.0273	$0.5506	$0.3856	$2.8774
Theoretical	1.162	.465	.0218	.1411	.0273	.5506	.3856	2.7534
Standard	.9152	.367	.0172	.1110	.0215	.4331	.3033	2.1683
MARCH.								
Actual	$1.2960	$0.4979	$0.02	$0.1281	$0.0248	$0.5000	$0.3502	$2.8170
Theoretical	1.25	.50	.02	.1281	.0248	.5000	.3502	2.7731
Standard	.9152	.367	.0172	.1110	.0215	.4331	.3033	2.1683

TOTAL COST PER TON OF TOTAL REFUSE FOR THREE MONTHS ENDED MARCH 31, 1911.

JANUARY.								
Actual	$0.7546	$0.2754	$0.0114	$0.0736	$0.0142	$0.2874	$0.2013	$1.6179
Theoretical	.710	.284	.0114	.0736	.0142	.2874	.2013	1.5819
Standard	.5491	.2201	.0103	.0666	.0129	.2600	.1820	1.3010
FEBRUARY.								
Actual	$0.7230	$0.2981	$0.0127	$0.0823	$0.0159	$0.3213	$0.2256	$1.6783
Theoretical	.678	.271	.0127	.0823	.0159	.3213	.2256	1.6062
Standard	.5491	.2201	.0103	.0666	.0129	.2600	.1820	1.3010
MARCH.								
Actual	$0.7262	$0.2790	$0.0111	$0.0717	$0.0138	$0.2801	$0.1962	$1.5781
Theoretical	.702	.280	.0111	.0717	.0138	.2801	.1962	1.5549
Standard	.5491	.2201	.0103	.0666	.0129	.2600	.1820	1.3010

Advice Regarding Construction Camps is given in the July Bulletin of the Connecticut State Board of Health (Joseph H. Townsend, M. D., Secy., Hartford, Conn.) as follows:

During the summer and fall there are located at various places throughout the state a number of camps occupied by laborers who are engaged in construction work on railroads, state highways, water reservoirs or other public works. Unless these are conducted in a thoroughly sanitary manner, they may be a menace not only to the health of the individuals occupying them, but also to the inhabitants of the towns in which they are located, and it is one of the duties of the local health officer to see that they are maintained with a proper regard to hygiene and sanitation in every particular. Section 4699 of the General Statutes provides that every agent of a firm or corporation, and every person who shall maintain or have charge of any structure used as a boarding-house or place of abode for laborers employed by them, shall within 72 hours after such structure has been occupied for such purpose, notify the health officer of the town in which such structure is located. Such health officer must then within five days inspect the premises and may make such orders as he deems necessary, or may forbid the use of the camp altogether.

Particular attention should be given to those camps which are so located as to be liable to pollute any public water-supply. If there is danger of this and another location is not practicable, all excreta from the occupants of the camp should be deposited in water-tight pails or other receptacles and daily carried off the watershed. Where the water supply of a neighboring town, not in the jurisdiction of the health officer where the camp is located, is threatened, then the health officer should notify the health officer of the town or city using the water. This is very important at this time of the year when typhoid fever may be prevalent and when we are fearing an importation of cholera from abroad.

Preliminary Surveys for the Puebla & Pacific R. R. of Mexico.

By H. N. ROBERTS.*

Extensive deposits of coal and iron ore are located in the state of Oaxaca, Mex., in the part known as the Mixteca country, included between parallels 17° and 19° North Latitude and 97° and 98° of Longitude West of Greenwich. These deposits were first investigated by Mr. A. B. Adams in the summer of 1906. The company formed by Mr. Adams to develop the mines is the Oaxaca Iron & Coal Co., with headquarters in Mexico City.

The nearest railroad is from 70 to 90 miles from any of the company's properties, and all of these roads are of narrow gage, the nearest standard gage connections being at the city of

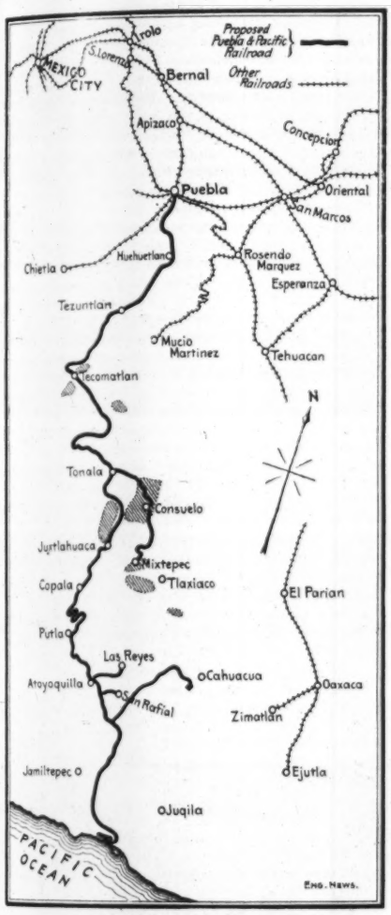


Fig. 1. Sketch Map Showing Location of the Proposed Puebla & Pacific R. R., Mexico.

Puebla, some 180 miles to the north. Detailed reconnoissances showed the country to be rich in agricultural produce such as tropical fruits, cotton, tobacco, and cattle; therefore, it was decided that the proper solution of the transportation question was to construct a through standard gage line from Puebla to the Pacific coast.

In accordance with this plan, the Puebla & Pacific R. R. Co. was organized by Mr. Adams, and a Federal concession secured, under date of May 26, 1910, granting a government subsidy of 12,000 pesos per kilometer. After several routes had been examined and discussed, the preliminary surveys were started over the route via the town of Huehuetlan (see map, Fig. 1), with the author as assistant engineer in charge of field work.

The elevation of the plateau, upon which is situated the city of Puebla, is 2,160 meters above sea level. This plateau slopes gently to the south, having an elevation of 2,070 at the pass at Kilometer 23. At Kilometer 16, where the line crosses the Atoyac River, is the first bridge of any magnitude. This crossing requires a bridge about 200 ft. in length.

At Kilometer 23 the problem to be solved was the best manner of effecting the descent to the Huehuetlan River at Kilometer 50, and elevation 1320. An attempt was made to get down on a 2% compensated line, but this was abandoned and a line was located down the Huehuetlan cañon under the direction of Mr. F. W. Blackford, M. Am. Soc. C. E., who was at this time appointed Chief Engineer.

The line down the cañon was found to require a 3% compensated grade, and to be 18 kilometers shorter than the 2% abandoned line. This cañon, from the divide at Kilometer 23 to Huehuetlan, Kilometer 50, is not, in general, crooked, although at some points the bends are so sharp that the adopted maximum curvature of 10° metric (equaling about a 16° U. S. curve) will not go around them, and short tunnels from 100 to 300 ft. long will have to be resorted to in a few places. The excavation will be solid rock, mostly a hard limestone.

At Kilometer 36 a waterfall 38 meters (125 ft.) in height is met with. The line at this point will develop back in the hills, doubling back again on the cañon, necessitating some four kilometers of heavy work. This waterfall is shown in Fig. 2.

The preliminary surveys showed that the maximum grade elsewhere on the northern division from Puebla to Consuelo would be 1.5%, compensated at the rate of 0.5% per degree of curvature. This cañon grade, from Kilometer 23 to Kilometer 50 will, therefore, be operated as a pusher grade, thus making the maximum for the whole northern division a 1.5% compensated, a light maximum grade for Mexican roads.

From Kilometer 50 the line follows the valley of the Huehuetlan River to Kilometer 68, where the Huehuetlan River joins the Atoyac (see map, Fig. 1). The Huehuetlan valley is extensively cultivated, great quantities of tropical fruits, sugar cane and corn being the principal staples.

From Kilometer 50 to Kilometer 66 the construction will be comparatively inexpensive, but near Kilometer 80 the Atoyac River valley closes in and the river makes a series of sharp bends, the necks being of a hard red conglomerate; these bends are too sharp to be rounded with the maximum curve and will have to be crossed by the line. The grade will be broken over these necks, thus avoiding the necessity of tunnels. As the grade of the river from Kilometer 68 to Kilometer 112 is about 0.6%, this would permit of the use of about a 0.8% compensated gradient; but as this distance, over which the work is light, is only 44 kilometers, not much benefit would be obtained in using a lighter maximum grade; therefore, the maximum of 1.5% compensated will be used where necessary to cheapen the construction.

At Kilometer 112 the line leaves the Atoyac River and cuts across to the Mixteco River by way of the Piaxtla summit. The Atoyac River will be crossed by the line over a 150-ft. span bridge at Kilometer 112, at elevation 1015. The line passes the town of Tehuitzingo at Kilometer 125, and the Piaxtla summit at Kilometer 134, and elevation 1180.

From Piaxtla summit, at Kilometer 124, the line follows down the tortuous cañon of Piaxtla, passing the town of that name at Kilometer 140, the town of Tlasquapa at Kilometer 152, and reaching the Mixteco River at Kilometer 156. On this portion of the line there will be some 8 to 10 stream crossings, of about 80-ft. spans, and 10 to 14 ft. above the stream bed. The bridge across the Acatlan River at Kilometer 165 will be 250 ft. in length.

From Kilometer 112 to Kilometer 140 extensive tracts are devoted to corn growing and cattle raising, especially in the vicinity of Kilometer 135 the Piaxtla plains of from 15,000 to 20,000 acres in extent are very fertile, giving excellent returns. Down the Piaxtla cañon sugar cane is grown, the primitive mills making crude sugar for export. Again from Kilometer 156 to Kilometer 170 the valley on both sides of the river is under corn cultivation, and on the sandy flats along the river's edge watermelons are grown in large quantities; the town of Tecomatlan owes its existence mainly to the watermelon trade.

On account of the recent political disturbances in the republic the work of the surveys was stopped temporarily at Kilometer 170 on Feb. 1, 1911. From the results of these surveys, preliminary only having been run, an estimated cost of $9,350,000 (Mexican currency) was made for the line up to Kilometer 170, being an average of $55,000 per kilometer ($44,000 U. S. per mile), exclusive of the Puebla terminal facilities. Based upon the total expenditures of the field force the average cost of the preliminary surveys per kilometer was $40 Mexican currency ($32 U. S. per mile).

The work was through a country entirely unknown to any but the indigenous tribes which have made their homes here for centuries. Even the roughest class of maps with any pretense to the drainage systems were not obtainable. Supplies were packed on muleback as far as three days' trailing. Native peon labor was

Fig. 2. Waterfall at Kilometer 36, Proposed Puebla & Pacific R. R.

relied upon for the lower ranks, and these men earned from 50 cts. to $1.25 Mexican currency per day. These Indians seemed to be very willing workers but slow. The amount of line run per day was from 2 to 5 miles.

From where the preliminary surveys were stopped, at Kilometer 170, the line will follow up the Mixteco River and its tributaries to the Consuelo coal mines, at about Kilometer 280, and elevation 2100. The construction will not be cheap, but no great difficulties will be encountered.

The heaviest work on the entire line will be at Copala summit at about Kilometer 360, elevation 1800, where the line, after passing the summit by a 2,200-ft. tunnel, starts the vertical descent of 1,100 meters (3,600 ft.) to the Putla valley. This descent will be all pure development work of an expensive type, as the country is precipitous, and the mountains fall off to the elevation of 700 meters in about 5 miles. The line will lay in the Putla valley to the point where it joins the Atolloquilla valley, and thence following down the Rio Verde valley to the Pacific coast at the Laguna Chicahua, at about Kilometer 580.

The Putla valley, and in fact the whole country from Putla to the Pacific is one of the richest agricultural regions in the republic; cotton, tobacco, tropical fruits of all kinds, sugar cane, and valuable hard woods of many classes, are in abundance. With even the crude and primitive means employed by these natives the cotton crop returns them ten for one, money value, per year; for these low lands are exceptionally fertile, with water in plenty. The Laguna Chicahua, the Pacific terminus of the road, is landlocked, thus furnishing an excellently protected natural harbor.

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Reinforcing the Pecos Viaduct, Built Twenty Years Ago.

The noted Pecos Viaduct of the Galveston, Harrisburg & San Antonio Ry. (owned by the Southern Pacific Co.) was built in 1891. A full description with views and drawings was given in Engineering News of Jan. 5, 1893, p. 2; a pen sketch of the structure during erection is reproduced herewith as Fig. 1, from our issue of Feb. 6, 1892. The viaduct was reinforced in 1910, because locomotives and cars had become too heavy and for some years past the traffic over the line has been handicapped by the fact that the old viaduct limited the size of engine which could be used. It was desired to bring the capacity of the structure up to the standard loading of the Southern Pacific Co., about equivalent to Cooper's E-55. This proved to be possible without sacrificing much of the old work.

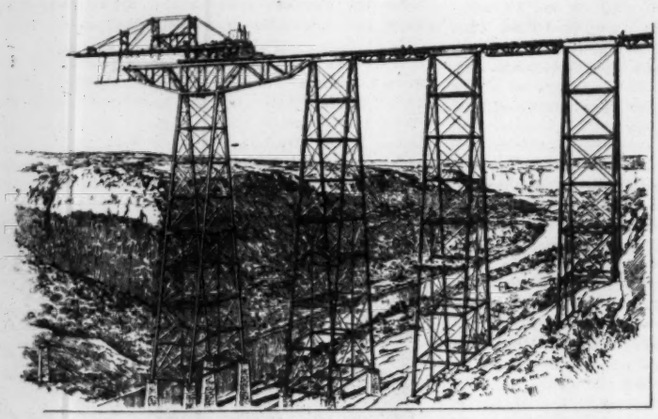


FIG. 1. SKETCH OF PECOS RIVER VIADUCT DURING CONSTRUCTION.
(Reproduced from Engineering News of Feb. 6, 1892, p. 125.)

Mr. W. H. Alderson recently described the reinforcement operations before the Western Society of Engineers (see "Journal" of the society for April, 1911, pp. 334-350). We quote below the larger part of his paper.

The Pecos Viaduct as built was 2,180 ft. long between abutments, and comprised 43 simple spans 35 to 65 ft. long, and a three-span pin-connected cantilever structure of 185-ft. channel span and 85½-ft. anchor spans, all resting on steel towers 35 ft. long. The deck was single-track, and all girders and trusses were spaced 10 ft. apart. At the three highest towers the steelwork is 269 ft. 5 ins. high from top of piers to base of rail, and rests on tall stone piers which rise to 51 ft. 5 ins. above low-water level, making the total height from low-water to rail 320 ft. 10¾ ins. The two towers carrying the cantilevers are 240 ft. 10⅞ ins. high from base to cap, and the trusses here are 28 ft. 6¼ ins. deep; the third tower is 264 ft. 4½ ins. high from cap to base, carrying the 48-in. tower girders.

None of these figures were changed in the reconstruction except that the length between abutments was reduced to 1,516 ft. 3 ins. by taking out 19 girder spans and 18 towers of the low viaduct portion and replacing by earth fill, the earth fill thus being carried to about 55-ft. depth. All these spans were 35 ft. long (equal tower and intermediate spans), whereas the larger part of the present structure has 65-ft. (lattice girder) intermediate spans alternating with the 35-ft. tower spans.

An interesting peculiarity of the design of the old structure is that the eight columns of the two towers under the cantilevers were made of two built-up channels laced together, whereas all other columns were made of four 6-in. Z-bars. Almost as interesting is the fact that all the material was wrought-iron except the Z-bars, which were steel. The year 1891 was very late for wrought-iron construction.

The total weight of metal in the old structure was 1,820 tons (cost not stated). It was erected in 87 working days. The reinforcing, it may be noted, required about 1,100 tons of new steel, costing about $120 per ton or 6 cts. per lb. erected.

The designed loading of the old structure was 5,000 lbs. per lin. ft. with a concentration of 30,000 lbs. In recent years the heaviest engine allowed to operate over it was a Mogul with 140,000 lbs. on drivers. At all times trains had been required to come to a full stop before crossing and to run slowly while crossing (10 mi. per hr.); this, with careful inspection and maintenance work, had preserved the viaduct in excellent condition.

Quoting Mr. Alderson's paper, the methods of reinforcing and the reasons for choosing these methods are as follows:

It was necessary that the work should be done under traffic, and several schemes were considered for reinforcement.

PRELIMINARY PLANS.—For the 35-ft. girder spans it was first proposed to put in falsework for about three spans from either abutment, removing these spans to either bank and there adding the necessary reinforcing steel, after which these spans could be substituted between trains for three other spans, the spans taken out reinforced and substituted for three more, and so on until all spans were reinforced, the last three being placed in the panels where the falsework was used. But when the 35-ft. spans at the ends of the anchor arms were considered, it was found impossible to get them out on account of the details at the ends of the anchor arms. The cantilever trusses required a very large amount of metal to be added, a large numb[illegible] to be cut out; and new holes to [illegible] these reasons it was decided to p[illegible] cantilever trusses and new 35-ft. [illegible] jacent to the anchor arms.

The 65-ft. lattice girders were [illegible] a very small amount of reinfor[illegible] for strengthening the details and top chord for transverse stresses. which would allow of doing this w[illegible] terfering with traffic or weak[illegible] while reinforcing them.

New center girders for all of [illegible] were then considered. This re[illegible] ably more metal than for rei[illegible] spans, but did not involve the ex[illegible] ing the 35-ft. spans.

ADOPTED PLAN.—It was co[illegible] able to have three girders for all [illegible] and cantilever trusses, and two [illegible] 65-ft. lattice-girder spans, so it [illegible] put in a center line of girders an[illegible] whole length of the structure, [illegible] 65-ft. spans could be easily reinf[illegible] logical way to carry the load fro[illegible] ders to the columns was found to [illegible] transverse girders at the tops of [illegible] that plan was adopted. These [illegible] were made double, each half being [illegible] face of the columns, with a diaphragm placed in the center connecting the two halves.

While the existing bracing was sufficient in amount, the time and expense of cutting it to clear the center trusses and girders, as well as making connections, rendered its use impracticable, so new lateral bracing for all spans was decided upon. New cross-frames were used between the center and outside girders. For the cantilever trusses the new sway braces had diagonal rods, except at the inclined posts at the ends of the anchor and cantilever arms, which had diagonals made of rigid members. The rods were in pairs and were threaded on the ends, having nuts bearing on lug angles riveted to the faces of the posts of the old trusses. This permitted the new rods to be put in place and tightened up before the old ones were removed. The posts on the center truss were slipped in between the rods, but not connected to them, so that the center and outside trusses could deflect independently.

The center 35 and 45-ft. girders were made the same depths as the old outside girders. For the 65-ft. lattice spans new center plate-girders were used, which were the same depth as the old spans, and were reduced to 4 ft. at the ends in order to be the same depth as the adjacent 35-ft. spans. The new cantilever and suspended-span trusses had the same outlines as the old trusses, but were made riveted instead of pin-connected.

The new center girders and trusses were de-

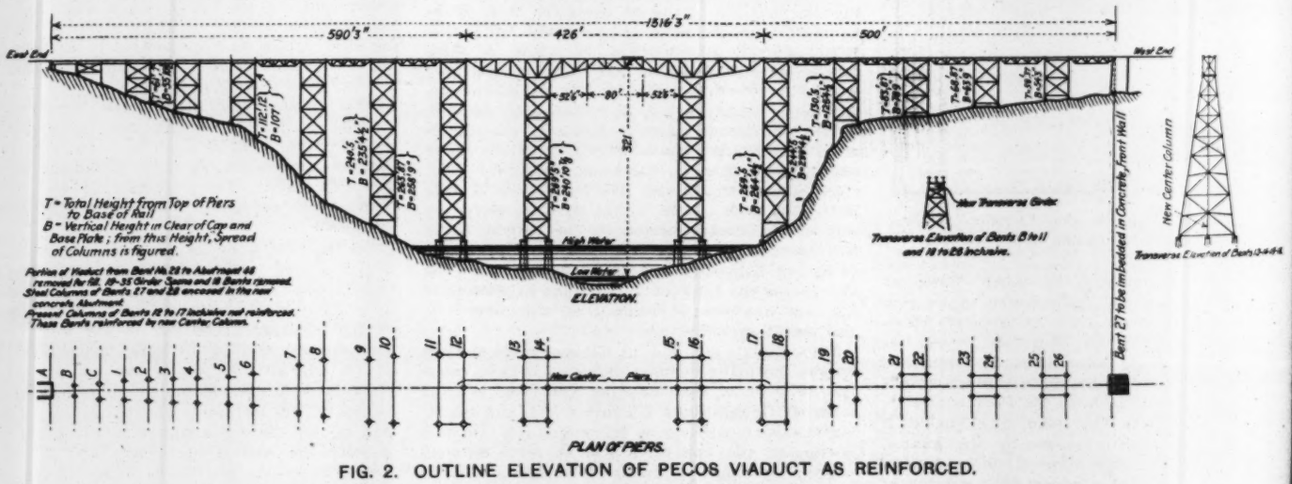

590'3"
426'
1516'3"
500'
East End
West End
T = Total Height from Top of Piers to Base of Rail
B = Vertical Height in Clear of Cap and Base Plate; from this Height, Spread of Columns is figured.
High Water
Low Water
ELEVATION.
New Transverse Girder
Transverse Elevation of Bents 8 to 11 and 18 to 28 Inclusive.
New Center Column
Bent 27 to be imbedded in Concrete Front Wall
PLAN OF PIERS.

FIG. 2. OUTLINE ELEVATION OF PECOS VIADUCT AS REINFORCED.

signed to carry five-eighths of the load on the track, that being the proportion carried to them if the ties acted as continuous beams. The old trusses and girders were found, after careful checking, to be safe for one-quarter of the load on the track, which load would be carried to them if each half of the tie acted as a single beam. It was thought that the real action of the tie in distributing the load would be somewhere between these two assumptions.

The Z-bar columns were reinforced by adding four 3½ by 3½-in. angles placed as shown (in Fig. 3), and if this did not add sufficient section four 7-in. plates were also added. At the horizontal struts in the lateral bracing the plate wa[illegible]

notched around the same, and the outstanding leg of the angles was cut off. The section was made up by putting on an angle riveted to the flange of the Z-bars with its outstanding leg in the same plane as the Z-bar web. Batten plates were used connecting the reinforcing angles to stiffen the columns. These plates were made long enough for three rivets and were placed 4 ft. apart.

The transverse girders at the tops of the bents had connection angles riveted to the outstanding flanges of the Z-bars. Shelf angles were provided to facilitate the erection of these girders.

When the columns in bents 12 to 17, supporting the cantilever trusses, were considered, it was found that so much metal would have to be added it was practically impossible to reinforce them. These columns were found to be of sufficient section to carry the load on the outside trusses, so it was decided to add a new center column to these bents. The new center columns were made of two plates and four angles, or of two built channel sections. They were built in halves in the shops, and the lacing and batten plates were riveted on in the field. This made it unnecessary to cut any of the old bracing, except the longitudinal struts on the center line of the bridge. The bents had a vertical strut on the center line of the bridge for about half their height, and the old strut was inclosed by the new center columns. These new center columns were braced laterally by being connected to the old horizontal struts, but not to the diagonals. The two center columns in a tower are braced longitudinally by a system similar to that of the outside inclined posts.

It was found that the columns in bents 11 and 18 would have to be reinforced even if new center columns were added, so it was decided not to use them in these bents. However, the old center vertical strut was extended up the full height of the bent and connected to the center columns of the opposite bents by a system of longitudinal bracing.

The tops of the new center columns at the ends of the anchor arms have a short length of stub column made to telescope into the main-column section, the holes for connecting the top section being drilled in the field. This allowed a vertical adjustment of the links at the ends of the anchor arms. At the ends of the old anchor arms there was a short link pin connected to both the truss and the column. A similar detail was used on the new truss. These links were made in halves so that the pin could be set in the end of the truss and the halves of the link slipped over it, as there was not room enough to drive the pin through both link and truss.

NEW PIERS.—For supporting the center column, an A-frame or truss carrying the load to the existing piers was considered, but it was found impracticable to get a bearing on the old piers, not on account of the piers being too small, but on account of their being placed diagonally to the center line of the bridge. For this reason new center piers were decided on.

The new piers are similar in shape and size to the old ones and, like them, were made diagonal to the center line of the bridge. Their tops are 2 ft. below the tops of the old piers, which was done to allow the base of the new column to clear the old bottom strut of the bent. This base was made in halves, like the rest of the column, the two halves being connected by field rivets through the outstanding legs of the vertical angles on the wing plates.

ERECTION.—In carrying out this work in the field it was desired that unnecessary chances were not to be taken in order to hasten the work; at the same time it was also desired not to delay traffic unnecessarily, and in order that the contractor for erection should be fully familiar with train movements, the railroad company stationed a telegraph operator at the bridge site.

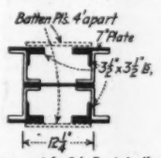
The material as received from the shops was sorted out and stored near the east end of the bridge, some temporary side-tracks having been put in for this purpose. The contractor set up an air compressor with a 4-in. pipe leading half way across the bridge, but reduced it to a 3-in., and later to a 2-in. pipe. At the center of each tower a 2-in. pipe led vertically downward from this main, and Ts were put in at each panel point in the tower, from which a hose connection was made to the riveters and drills. A derrick car was made by mounting an engine and an ordinary boom on a flat car, the boom having a reach of 40 ft. from the front of the car and a capacity of ten tons.

COLUMN REINFORCING.—The material for reinforcing the Z-bar columns was first distributed to proper bents and clamped in position. Drilling was started at the tops of the bents and progressed downward. A scaffolding was used for the drillers and riveters, which consisted of a longitudinal timber against the inclined legs of the tower. Across these, at the ends, were short timbers transverse to the bridge and against the face of the bents. At the intersection, diagonal planks were laid, forming a small platform around the column. This scaffolding was raised, when necessary, by the derrick car used for placing the steel.

The general procedure in reinforcing a column was to have a drilling gang at each column on one side of a tower, which worked downward for about one-third of the height of the high towers. The scaffolding was then raised to the top of the tower and riveting was done for the upper third; then the middle and lower thirds were finished in the same way. By having several sets of scaffolding it was possible to carry on reinforcing of several of the towers at once, drilling and riveting gangs being shifted from tower to tower as necessary. The material for center columns and transverse girders was lowered over the side by the derrick car; in the case of low towers, it was laid on the ground until a line could be dropped through the deck of the structure; the material was then carried up into its final position. In the case of high towers the material was held by one line until another could be dropped through the deck, when the material was picked up and hoisted in position as was done for the lower towers.

SETTING NEW GIRDERS.—For placing the 35-ft. girders and all of the cantilever trusses except the bottom chord, it was necessary to remove the floor of the bridge. This was done for one span length at a time, and did not interfere with traffic over the bridge.

The 65-ft. center girders weighed 18 tons and therefore could not be handled by the derrick car alone. By lifting one end of the girder, cribbing up just beyond the center of the span, letting that end of the span drop, cribbing up the end, and then raising and cribbing up the center a little more, these spans were gradually raised to the height of the flat car and skidded on to two cars. A gallows frame, having a set of falls leading from each upper corner, was built which could be placed on the top flanges of the old outside girders. An idler flat car, with a snubbing post on each side, was then placed between the locomotive (which was placed at the disposal of the contractor) and the two flat cars carrying the 65-ft. girder. By slacking off on one line or the other of the falls, the girder could be swung from side to side. This gallows frame was set by a derrick car, and the derrick car then moved off the structure, when the locomotive and three flat cars were moved out into position. One end of the girder was picked up by the two lines from the gallows frame which passed around a sheave at the bottom of the frame and led out horizontally to the snubbing posts on the flat-car idler. By pulling ahead with the locomotive, this end of the girder was lifted, the derrick car raising the other end, when the flat cars on which the girder was loaded were pushed out through the gallows frame by hand. A small wooden pedestal was built which now supported the end of the girder raised by the derrick car, the other end being held by the lines from the gallows frame. The derrick car then removed the ties and rails from the 65-ft. span and the center girder was lowered in position from the gallows frame and derrick car, the total operation taking fourteen men about 4½ hrs.



Reinforcement for Cols. Bents 1 to 11 inclusive and Cols. Bents 18 to 26 inclusive.

Fig. 3. Section of Z-bar Columns and Reinforcement.

CENTER TRUSS.—The new cantilever trusses had the lower chord placed first, and the contractor was allowed to cut only one panel length of the lateral bracing at a time. The chord was suspended from the old structure by means of 12 × 12-in. beams. The web members were then placed for a few panel lengths and the upper chord lowered over them. As mentioned before, the new diagonal rods were put in place and tightened up before the old rods were removed and the new vertical posts slipped between them. In this way the cantilever was gradually built, one member at a time, the new center trusses being supported from the old structure. Closure was finally made by wedging up the new center trusses.

The reinforcing material was fabricated by the Phoenix Bridge Co., and the erection was done by the Missouri Valley Bridge & Iron Co. The amount of reinforcing steel added was about 2,200,000 lbs.

As a whole, the entire work was very satisfactory. Plans for reinforcement were prepared by the writer under the direction of Mr. John D. Isaacs, Consulting Engineer of the Harriman Lines. Mr. D. K. Colburn, Bridge Engineer of the Galveston, Harrisburg & San Antonio Ry., had supervision of the erection.

We may add that the original viaduct was also built by the Phoenix Bridge Co.

The Wicked, Inconsiderate and Destructive Road User.*

By ARTHUR GLADWELL.†

The road user is not an individual, he is an aggregation of all that is wicked and inconsiderate; no sooner has the careful and much-abused "highwayman" made or repaired a road than the "user" conspires with his fellows to destroy it. None can seriously urge that the average road user is an ordinarily careful person. If he is the owner or driver of a traction engine or heavy motor he is careful only to do those things which will best and soonest ruin the work of the road-maker, by refusing to break track on the roads he traverses, by overloading, by reckless driving, by stopping to take water at frequent intervals from roadside ponds, and leaving as toll all the clinkers and other muck he can scrape together on the side of the road or on the road itself, and in other ways to leave his trail of damage and dilapidation wherever he goes. He appears to take an especial delight in destroying the edges of footpaths and the verges at the sides of country roads; but his chief joy is to come out just after a frost has been succeeded by a thaw, doing damage which costs probably a hundred pounds in good money to make good, while the total value of his load is under fifteen pounds.

Apart from the serious public nuisance this class of traffic (as now conducted) has become, the economic question arises, where does the profit or good come in when the damage occasioned to public property so far exceeds the total volume of the goods transported? The law of extraordinary traffic is in serious need of amendment so long as such a condition of things obtains, and it cannot be denied that any form of traction capable of doing such enormous damage to our roads must be inherently defective in design, and requires to be revolutionized.

If our road user is a motorist, he is sometimes, but not often, a careful user; but in far too many instances, the man who acquires a motor-car appears to think that "the earth, and all that therein is," has been included in the purchase. He certainly appears to entertain an unshaken belief that the reversion in all the roads of the universe has fallen to him, as tenant in possession in perpetuity. It is useless to consign this class of person to the only appropriate place for him owing to the impossibility which exists of storing petrol in those parts. There is consolation in the fact that he is slowly killing himself off.

Let us be scrupulously fair. It is now contended by the motorist that he is contributing towards the upkeep of the roads; so he is, but at whose cost were the roads first made, and in proportion to user how far short in his proportionate contribution does the motorist come, and will ever remain? He certainly does not pay, nor is he ever likely to be called on to pay, anything like a full and fair proportion of the cost of road maintenance and improvement, and until he does, he should be satisfied with his share of the road, and not attempt to drive everybody else off it, as some do. In saying this, it must not be concluded that the author is hurling anathema at the whole body of motorists. He is simply protesting in perfect sincerity against the pretensions of a certain section of motorists, whom all know, and is prepared to acknowledge with equal sincerity that others of the fraternity are not only considerate, but are essentially fair-minded men, who realize the difficulties of the situation, and who are extending the encouragement of their sympathy and support to those who are working for the betterment of our roads.

There are, of course, other road users, which could be enumerated. There are a few horses still remaining, but their decreasing numbers are significant of the changed conditions of road user, while the commercial and manurial value of road scrapings in country districts is steadily declining.

*Extracts from a paper read before the annual meeting of the Institution of Municipal and County Engineers, England.

†Engineer and Surveyor to the Eton Rural District Council, England.

Experiments to Determine the Duty of Water on Irrigated Lands in Idaho.*

By DON H. BARK.†

Although irrigation has had rapid development during the past decade, there are still millions of acres of arid land without irrigation. Water-supply is limited, and it is the one factor that will determine the extent of ultimate irrigated area. For this reason no phase of irrigation is at present of more importance than the duty of water. Different soils and crops require different amounts of water, and it is certain that a better knowledge must be obtained of the water requirements of these different soils and crops before the large projects of the future can be properly planned and constructed.

A cooperative agreement for carrying on the present investigation was entered into between the State Board of Land Commissioners, through the State Engineer, and the Irrigation Investigations branch of the U. S. Department of Agriculture. The author has had charge of Government irrigation investigations in Idaho for the past two years, and planned and supervised this investigation. The Idaho Irrigation Co., the Twin Falls North Side Land & Water Co., and two irrigation districts of the Boise Valley, together with the U. S. Reclamation Service and Oregon Short Line R. R., have also contributed to the investigation.

Conditions Affecting the Duty of Water.

The amount of irrigation water used differs in nearly every locality, but owing to the indifference and lack of knowledge of the irrigators, the amount used is not, in all cases, the actual amount required for maximum crop production. There are a number of conditions which affect the duty of water very materially; the principal ones are:

CHARACTER OF SOIL AND SUB-SOIL.—The texture of the soil as regards porosity has more to do with the amount of water used than any other one thing. It has been found that adobe soils may be irrigated with the total application of but two or three acre-inches, while in some instances, from one to two acre-feet are required to spread over and thoroughly irrigate an acre of the very gravelly soil. At least two-thirds of this latter amount is almost invariably wasted, as it either passes into the ground water or percolates beyond the reach of the plant roots. Where coarse soil is encountered without an underlying impervious stratum, some irrigation system must be used which will flood the ground quickly before the water has time to penetrate too deeply, if a high duty is to be secured. Ordinarily, the best means of accomplishing this is to divide the field into short runs from 200 to 400 ft. long, with frequent cross ditches, and then, by using large irrigation heads, giving from 2 to 4 sec.-ft., the ground can be flooded quickly and economically without much loss from percolation.

More water is lost from coarse soils through evaporation than from the finer ones, for capillarity acts more rapidly in the former, thus bringing larger amounts of water to the surface. The duty also depends, to a large extent, upon the depth of the soil. Shallow soils cannot absorb or retain as much water as deep soils, and hence require more frequent irrigation. This necessitates the use of a larger amount of water on shallow soils in order to make up for the extra evaporation which takes place from the surface by reason of its being kept wet by the more frequent irrigations.

CLIMATIC CONDITIONS.—The annual precipitation and its seasonal distribution, together with the temperature, humidity and wind movement have a marked effect upon the amount of water required for crop production.

DIVERSIFICATION OF THE FARM CROPS.—Most water contracts call for a constant continuous flow in the ditch, and where a farm is devoted to one crop such as grain, hay or potatoes, the greatest need for water is most likely to fall within a comparatively short period, and much of the water during the remainder of the season is liable to be wasted. By diversifying his crops, the farmer's need for water will be more constant, and he is better able to make good use of the continuous flow of the ditch, and a higher duty is thereby secured.

USE OF ROTATION.—It is a fact known to those who have been compelled to irrigate with small heads of water, that little can be accomplished in this way, as the stream soon dwindles and the field remains unirrigated. Rotation systems, by means of which a farmer can exchange water with his neighbor and use large heads for short periods, are now used with success in many localities, and the saving of water is very material. The rotation system has other good points; the principal one being that irrigation can be done quickly and economically, leaving plenty of time for cultivation, etc.

PREPARATION OF THE LAND.—Maximum crops cannot be secured without a uniform wetting of the soil, and this is not possible unless the land is properly prepared and leveled. Uneven land requires water to be held on it long enough to soak up the high spots. In addition to the large waste of water, much more time is required for irrigation.

Many irrigators dislike to have their fields cut up with cross ditches, but prefer to flood the water uninterruptedly from one end of the field to the other. This practice is exceedingly wasteful of water, particularly upon the more porous soils, for the water runs over the upper section near the feed ditch for so long a time before it reaches the lower end of the area, that sometimes as high as 90% of it percolates so deep on the upper part of the field as to pass beyond the zone of the plant roots, and is lost. In good practice, it seems best never to flood or run the water in furrows farther than from 400 to 800 ft. between feed ditches.

KIND OF CROP.—The kind of crop, whether cultivated or non-cultivated, and the length of season that it needs water have a very direct bearing upon the amount required. Spring grains need water for but a comparatively short time during the spring and early summer, while winter grains require it for a still shorter period on account of their earlier date of ripening. They also have the ability to make use of more of the moisture remaining from winter precipitation. On the other hand, pasture, the clovers and alfalfa need irrigation at regular intervals from spring until late fall. A rowed crop such as potatoes, corn, garden truck or orchard that can be cultivated between the rows will require, all other things being equal, less water than a non-cultivated crop on account of the decreased evaporation induced by the cultivation. The Irrigation Investigations branch of the U. S. Department of Agriculture has found that there is four times as much evaporation from an uncultivated soil in a single month as from one covered with a 3-in. dry soil mulch. This strongly emphasizes the desirability of thorough cultivation wherever possible.

GROUND WATER LEVEL.—The duty depends to a considerable extent upon the depth to ground water, particularly where it is near the surface. Water is transmitted by capillary action in all soils, the rate and extent of the transmission depending, to a large extent, upon the size and arrangement of the particles of which the soil is composed. The extent of the vertical rise by capillarity is rather constant, however, for each class of soil, and wherever the ground water rises near enough to the surface so that it falls within the limit through which capillarity can act, sub-irrigation is said to take place. This materially reduces the amount of water required and increases the duty, as the irrigation water is not subject to as much evaporation as it is when a system of surface irrigation is used.

LOSSES IN CONVEYANCE.—These are important factors which have a direct bearing upon the duty of water, when an entire project is taken into consideration; but as they have been eliminated in this investigation, by measuring the water at the head of each plot, they will not be considered in this report. Many other less important factors, together with the local conditions which obtain in each case, have some bearing upon the amount of water required, but the principal factors are those mentioned in the foregoing discussion.

The Idaho Experiments.

Each tract experimented upon was divided into three nearly equal parts, and Cippoletti weirs were installed in the feed and waste ditches leading to and from each tract. All feed and waste water was carefully measured, the waste being deducted in each case from the amount applied. The owner was allowed to irrigate one of the plots at such times and using the same amount of water as had been his usual custom. My assistants, who were specially skilled in the measurement of water were always on the ground during each and every irrigation, and the amount that the farmer applied to this tract was carefully measured. A larger amount was then applied upon one tract and a lesser amount to the third. Thus we had in each case three tracts of the same class of soil, planted to the same crop and handled in exactly the same manner; but upon which different amounts of water were applied during the season.

Water and yields were measured on about 60 different farms during the past season. The experiments include oats, wheat, barley, alfalfa, clover and potatoes upon a large variety of soils. Work was carried on from Caldwell in the west to Rigby on the east, in altitudes ranging from 5,800 ft. at Ketchum to 2,200 ft. at Caldwell. All data which may have any bearing on the duty of water has been carefully considered, and a careful classification of the soil has been made in each case. The work will be carried on along the same lines during the present season.

Owing to a variety of conditions there was a considerable diversity in the results obtained during the first season, even on the same class of soil. The highest duty was obtained upon the deep medium lava ash soils which were able to absorb enough water to last for a considerable length of time between irrigations. The tight impervious adobe soils absorbed less at an irrigation, but required more during the season on account of the more frequent irrigations which were necessary, there being a larger loss through evaporation from these soils. The soils to which the most water was applied and those which actually required the most water were coarse, gravelly soils. These soils must be flooded quickly and handled very carefully in order to secure anywhere near a reasonable duty. The present systems in use on most of the gravelly soils of the state are very wasteful; sometimes as high as 75% of the water being wasted through deep percolation. The amounts applied varied all the way from a minimum of nothing up to over 21 ft. in depth on a gravelly alfalfa field at Ketchum. The results secured during the season are all given in detail in the last biennial report of the State Engineer.

It seems to be quite the rule throughout the investigation that the largest amount of water applied produced the greatest yield. This was particularly true with alfalfa; but a careful study of the results shows that there is a certain amount with all crops on all different soils beyond which it is not profitable to go, if the value of water is taken into consideration. The small amounts, in almost every case, produced by far the greatest return per acre-foot applied. Grain crops, as a rule, were unusually light over the entire state last season, on account of a period of hot weather that was experienced during June and July while the grain was filling.

CONCLUSIONS.—The principal conclusions of the season's investigations were:

That such experiments must be carried on for more than one year in order to secure results that are final and far reaching. The principal reasons for this are the great annual variation in the seasons, the lack of uniformity in the yields from the different plots where like amounts of water were applied, and the elements of "personal equation" which enter into any investigation of this kind. The fixing of the proper duty of water for large bodies of land is too vital a question to be based on any one year's results.

It was also found that the time of irrigation, as well as the total amount of water applied, has a bearing on the amount of yield produced. This was found true most particularly with grains, and is another strong reason why the investigation should be carried on for a series of years.

The duty depends to a greater degree upon the class of soil than any other one thing. This was repeatedly brought out and emphasized during the season, but it is one, however, that must be carefully studied. It is firmly believed that after this investigation has been carried to completion, the duty can be accurately fixed within very narrow limits on any tract by a careful study of the soil and the various other conditions that must be taken into consideration.

It was repeatedly and emphatically brought out that, with the usual practice, there is a very great waste of water by deep percolation on all gravelly soils. In order to secure a reasonable duty on such soils, a system must be used that will flood the ground quickly before the water has time to penetrate too deeply. This can best be accomplished by using large heads giving from 2 to 4 sec.-ft., and flooding the water short distances, never over 300 or 400 ft. As long as farmers flood their irrigation water uninterruptedly over lands ½ mi. in length there will

*Abstract of a paper read before the Idaho Society of Engineers in February, 1911, combined with portions of a report on certain investigations, as published in the Biennial Report of the State Engineer of Idaho, 1909-10.

†Irrigation Engineer, in charge of Experiment Station of the U. S. Dept. of Agriculture, Boise, Idaho.

always be a great waste of water. The amounts absorbed are a poor guide as to the amount required by the crop in such cases. The desirability of proper leveling of the ground was also brought out very clearly.

The soils experimented upon consisted of two distinct classes: (1) the finely divided clay and lava ash soils, and (2) the coarse, sandy or gravelly soils. These two are so widely different in their absorptive and moisture holding capacity that the amounts used upon them cannot well be compared, and hence two separate comparisons must be made when summing up the results of this or any other investigations including both classes. Average samples of the 1st, 2d, 3d and 4th feet of soil from every tract experimented upon have been carefully taken and are now stored away and will be used for future reference. The amounts of water used during the present investigation represent, in the main, the normal amounts used on similar soils throughout the state.

A study of the results that were secured during last season, would seem to indicate that the best amount to apply to grains upon the tighter soils is about 1.77 acre-ft. per acre. Alfalfa seems to require at least 50% more than this amount, and has a decided tendency to produce the largest yield where the most water is applied. Gravelly soils of necessity require somewhat more; the amount depending upon the porosity of the soil and the efficiency of the system. It is to be regretted, however, that the present systems in use on these soils are generally very crude and wasteful.

An Official German Recognition of the Harmless Nature of a Slag Addition to Portland Cement Clinker.

Ever since the late Dr. Wm. Michaelis reported, some 25 years ago, that the addition of puzzolanic material to Portland cement subsequent to its burning improved its resistance to seawater without in any way damaging its other qualities, it has been the practice of a number of German cement manufacturers to produce a cement of this type known there as "eisenportland cement" or iron-Portland cement. The cement was made by the addition to a normal Portland cement up to 30% of ground puzzolanic material, sometimes trass, but more often blast-furnace slag, the grinding being done either before or after the mixing. It was immediately claimed by the "true" Portland cement manufacturers that such an addition was detrimental to the strength of the cement and a long fight started against the practice. One of the first results in the fight was the inclusion in the Portland cement specifications of the familiar clause, which has also been incorporated in the standard specifications of this country, to the effect that in a true Portland cement there shall be no addition greater than 3% subsequent to calcination.

The controversy came to a head on Nov. 21, 1902, when, at the solicitation of the Association of German Portland Cement Manufacturers, the Prussian Minister of Public Works ordered the Royal Materials Testing Laboratory, at Gross-Lichterfelde West, to investigate the properties of Portland cements subsequently treated with a large addition of ground slag, and at the same time prohibited the use of such cement on public works and its sale as Portland cement. In the eight years since that time these investigations have been under way by the Royal Testing Laboratory under the direction of Prof. Buchartz and have reported recently to the Minister. As a result of this report the Minister has issued a decision which holds that Portland cement and "Eisenportlandcement," specified as containing up to 30% of subsequently added ground slag, are to be considered of equal value, and that insofar as the latter conforms to the standards laid down for true Portland cement, it may be used on all public work. It is prescribed, however, that all such cement must be labelled "Eisenportlandcement," when sold. The German specifications for this cement and for true Portland cement were given in Engineering News, Aug. 25, 1910, p. 214.

The "Engineering Supplement" of the London "Times" gives the following account of the tests on which the decision was based:

Early in the eighties, Michaëlis found that the addition of puzzolana to cement improved its resistance to sea water. The sale of cement to which about 30% of slag had been added was practised by Prüssing, Planck & Co., and in the circulars issued with respect to this cement it was claimed that it had been improved by the addition of a material containing silica in an extremely active form. The Association of German Portland Cement Manufacturers decided to combat the growth of the practice. With this object in view, a deputation waited on the Minister of Public Works, who received them sympathetically, referred the matter to the Royal Material Testing Laboratory for investigation, and, pending the publication of the report, prohibited the use of iron-Portland cement in the carrying out of public works and the sale of such cement as Portland cement.

In the meantime, the Association of German Manufacturers of Portland Cement and of the Association of Manufacturers of Iron-Portland Cement carried out investigations on their own account. Among individual manufacturers, Dyckerhoff, especially, paid considerable attention to the question, and Lundteigen communicated a number of results to Erdmenger which indicated the advantageous results of the addition of certain natural silicious material. But the Prussian Material Testing Laboratory failed to find that these additions had the desirable influence attributed to them. Infusorial earth, trass, and a waste product obtained in the manufacture of alum were tested, and it was found that their effect on test-pieces stored in air, moist sand, or sea water, was to reduce the strength of the cement mixtures. The effect of the addition was more pronounced in the 1:7 mixtures than in the 1:3 sand cement mortars. In the latter case the strength of test-pieces made with cement containing 33% of silicious matter was only 70% of that exhibited by the pure cement.

Dyckerhoff's results, published in 1905, showed that certain of the iron-Portland cements exceed the tests of certain brands of Portland cement when tested in accordance with the requirements of the German Standard Specification. Comparison of the tests of both classes of cement mortars filled into the molds in a plastic form and rammed in fairly dry indicate that the iron-Portland cements are distinguished by their relatively low strength.

In 1907 Framm published the results of a long series of tests on the two classes of cement, these being the official tests of the Association of German Manufacturers of Portland Cement. The general results of his work indicated the distinguishing feature of the iron-Portland cements to be that they exhibit a lower test when exposed to air than do Portland cements. It may be observed that both classes of cement, according to thes results, behave very similarly when exposed to the weather, in the open, except that the 1:7 mixtures of iron-Portland show a rather lower strength than do the Portland cement briquettes. Passow, on the other hand, gives figures which show that in these respects both classes behave similarly. From these most contradictory results it is impossible to arrive at any satisfactory conclusion as to the influence of the addition of slag to Portland cement. Yet they comprise the fullest and most authoritative work.

The work of Burchartz, which is also the work of the Royal Material Testing Laboratory, has done much to dispel this uncertainty. In the course of his tests the suggestions of both the Portland cement and the iron-Portland cement manufacturers received attention. His tests of mortars composed of two parts of sand to one of cement and of the 1:5 and the 1:7 mixtures did not indicate any essential difference in the behavior of the two classes of cement, the actual figures of the iron-Portland cements being either slightly above or below those of the corresponding Portland cement mortar. This held good whether the test pieces were exposed to air or were immersed in water, and as regards both tensile and compression tests. Experiments were carried out with the object of ascertaining whether the addition of sand had the same effect as the addition of slag, this being asserted by the opponents of iron-Portland cement; the results indicated that the addition of slag such as that used in the manufacture of iron-Portland cement did not reduce the strength of the cement in the same proportion as did the addition of sand. At the same time, the contention of some of the advocates of the addition of slag that the strength of a normal Portland cement is thereby increased received no support.

Further tests were carried out with the object of ascertaining the effect of adding various materials to cement. Two samples both of iron-Portland and of Portland cement were taken, and mixed in the proportion of one part of cement to two parts of rough sand with 30% of the cement replaced by a corresponding proportion of trass and of slag, and a further series of tests was carried out with 50% of the cement replaced by hydraulic lime. In all cases the lowering of the strength was the same for both classes. Attrition tests, carried out on the Martens machine, showed that the two classes behaved similarly; the results in this case were of a somewhat contradictory nature, but the information derived from them indicated that there was no marked difference. The variation in length of test-pieces stored in water and in air showed but slight difference for the two classes. Immersed in water the iron-Portland cement test-pieces exhibited a slightly greater expansion than the Portland cement, while in air they showed slightly less contraction. This result is at variance with that reached by Dyckerhoff, but it is confirmed by others obtained by Burchartz in investigating the action of weather on surfaces covered with a cement floating, those in which iron-Portland cement was employed showing fewer contraction cracks.

It must always be remembered that slag is a variable material. To be employed at all successfully it must have certain characteristics. It does not remove any difficulties in the manufacture of cement, but adds another factor which needs constant attention. The neglect of the physical form and of the chemical composition of the slag employed accounts for the anomalous results obtained by many investigators who have essayed to throw light upon the problem.

Attention is called to an editorial discussion, on another page, of the different kinds of cements in which iron or blast-furnace slag have a part.

John Burns on American Water Supplies.—At the opening last Saturday of the new pumping station of the Metropolitan Water Board [London] at Walton, Mr. John Burns, President of the Local Government Board, who performed the ceremony, told some humorous stories illustrating the absorbing interest taken by Americans and Canadians in their water-supplies. "A few years ago," said Mr. Burns, "I was in America, where they do things on a big scale. I was one of a party that was seeing a celebrated town, and was much amused at the description given by the guide of the river which flowed through its midst. 'Ladies and gentlemen,' he said, 'you see through the trees the broad and heaving bosom of the river. That is the source from which we get a very generous water supply. The poor use it for soup, the middle class dye their clothes in it, and the very rich top-dress their gardens and lawns with it. Drive on, Sam.'" Mr. Burns then told of an enterprising town in Canada which was anxious to score off a rival town in the East. A journalist writing of this town said: "Edmonton is a young and pushful city, which prides itself on its water-supply. We have no desire to depreciate our Eastern rival, but in the matter of water-supply we are far ahead of her. The wood, the flotsam, the jetsam, and timber are so bad in her reservoirs that they have to filter their water through a ladder. The citizens have to extract the water from the debris with a gimlet, and when they have done that they have to disinfect it with chloride of lime, manganese, and iron. This clearing process, however, does not suffice, because after all these operations are carried out so many dangerous bacteria escape that they have to be taken from the water into the back yard and killed with a club."—London "Surveyor."

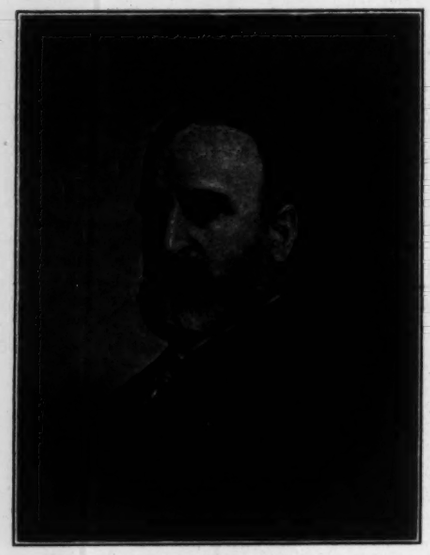
Rain Water Sewers for Valparaiso, Chile, of extraordinary size and design, have been built since the earthquake of 1906. The city is located on a plain at the immediate foot of the Andes mountains, which run up back of the town at a precipitate grade. After a rain, the run-off into the town is sudden and of great volume and in the past much trouble had been experienced by bursting culverts and by the accumulation of sand in the sewers in great quantity. Advantage was taken of the reconstruction of the public services after the earthquake to rebuild these rainwater conduits for these emergency conditions. The sewers are of different dimensions but of the same general design, a reinforced-concrete rectangular section of sufficient size to allow the entrance of a man to clean out deposits after heavy rains. The largest section has total width of 34.8 ft. and is 6.6 ft. high; it is divided by a vertical wall 2 ft. wide into one section 20 ft. wide and one 12.8 ft. wide. This wall is only 4.6 ft. high and the arched roof construction, designed to carry a 20-ton road roller plus ordinary street traffic, is carried on short columns spaced 8 ft. c. to c. The smaller section is to be used as an auxiliary during cleaning operations, which can be carried on at times of normal flow when the middle wall will not be overtopped.

James Christie.

We are pleased to be able to reproduce below a portrait of the late James Christie, of whom a short biographical sketch appeared in our obituary column of last week.

Mr. Christie will long be remembered as one of the prominent engineers in the field of bridge and structural manufacture. His tests of built wrought-iron columns made for the Pencoyd Iron Works, in 1883, and discussed in a paper read before the American Society of Civil Engineers on Oct. 3, 1883, form a classic in the annals of the profession. The results of these tests were subsequently published in the pocket-book of the Pencoyd Iron Works and have been familiar to engineers for many years.

The following year he presented a paper before the same society on the strength and elasticity of structural steel and its efficiency in the form of beams and struts, which contained much valuable information on a subject which was then of immense interest to all bridge and structural



James Christie.

engineers. Both papers added greatly to the existing knowledge of built structural members, and called forth discussion and praise from the highest authorities on bridge and structural engineering in this country.

The effect of the mechanical treatment of steel and iron, the effect of shearing, punching, reaming and drilling upon the strength of the member, were carefully studied and analyzed by him in a paper prepared for the International Engineering Congress at the Columbian Exposition in 1893, and printed in the Transactions of the American Society of Civil Engineers of that year.

Mr. Christie was active also in the discussions of the American Society of Mechanical Engineers. He was for many years active in the Engineers' Club of Philadelphia, and his frequent participation in the discussions of that society displayed a remarkably broad knowledge of engineering subjects. He was twice elected president of the club, an honor which has been accorded to but one other man in its history.

After a long term of years spent in the employ of the Pencoyd Iron Works, Mr. Christie became an important factor in its successor, the American Bridge Company. The great enterprise of the new combine, building a very large fabricating plant at Economy (Ambridge), near Pittsburgh, engaged him in his last work of magnitude. He directed the design of the mechanical equipment of the new plant, with its varied novel machines and appliances, including the 2,200-ton tension testing-machine, the largest yet put into operation. After these labors he retired, for well-earned rest.

Mr. Christie accomplished his work and achieved prominence despite the fact that his early educational advantages were meager. He was a close student of engineering progress, a man of prodigious industry, and with an equally prodigious memory. His recognized integrity and engaging personality secured and held the esteem and affection of his assistants. His modesty and courtesy, his kindliness and gentleness of disposition, are too well known to his many friends and acquaintances to be here commented upon.

Plans for Future Work Toward Raising the "Maine"

In our issue of Aug. 3, 1911, p. 142, we noted that an additional $250,000 was to be asked of Congress to continue and complete the work incident to the raising of the "Maine" from its present berth in the mud of Havana harbor. This request was made by the President in a special message to Congress, dated Aug. 21, the day before the adjournment of the recent extra session, and was not formally acted upon, though the War Department was informally notified that the present appropriation could be exhausted upon the supposition that further work would be provided for by funds immediately upon the reconvening of Congress in December.. The appropriations up to date have totaled $650,000, of which there remained available on Aug. 1 about $145,000. It is now plainly manifest that this is insufficient to carry the work to its projected completion, though with proper administration it may be enough to maintain a fair state of progress until the first of the year, when the additional necessary amount may be expected to be authorized.

In order to keep intact the plant and organization now employed until the new appropriation is available the Chief of Engineers has outlined the following scheme of work for the next few months:

(a) Bulkhead, pump out, and clear out the one-third after portion of wreck so far as possible and cut it off from the two-thirds forward badly-wrecked portion.

(b) Remove mast, and ship same to Arlington for storage, leaving funds for its erection to be provided later by Congress during next session.

(c) Cut down forward two-thirds of wreck to levels already reached by pumpage, and dump wreckage in deep water outside Havana Harbor as soon as possible after Navy Department has had opportunity to finish its measurements and photographic records.

(d) Remains of dead, which will by that time have been collected so far as possible (no hope of then finding any more except in fragments too small to identify or even preserve) to be then sent to United States for storage at Arlington to await funeral services after further allotments of Congress during next session.

(e) Build small coffer inside of main cofferdam so far as possible around front two-thirds of wreck, add bracing where fo[illegible] necessary, and remove this part of wreck [illegible] to 40 ft. below harbor level, or at least [illegible]mly to as great depth as funds will allow [illegible]ll stopped by hurricane or other accidents; [illegible]ing funds enough only to fill up cofferdam [illegible] water, to lay up plant (both Cuban and [illegible] States) until Congress has time to a[illegible]ate more funds, to pay off all employees ex[illegible] watchmen, and to send other employees [illegible] to places promised them under terms of [illegible]

(f) Fill up cofferdam and la[illegible] plant and employees.

(g) This will leave rear one [illegible] of wreck probably bulkheaded and subme[illegible] but ready to raise by flotation and forward [illegible]-thirds cut down to 30 or 40 ft. below water [illegible] all out of sight under water inside main c[illegible]erdam.

(h) Funds will then be furth[illegible]eeded to

1. Reassemble plant and work[illegible] force.
2. Pump out the cofferdam.
3. Complete the removal work
4. Remove cofferdam piling.
5. Float away and sink the rear one-third of boat.
6. Dredge away cofferdam filling and other refuse.
7. Return plant to places from which secured
8. Repair plant borrowed from Cuba.
9. Erect mast and monument at Arlington.
10. Distribute mementoes so far as then ordered by Congress.

It is evident that the condition of the cofferdam will not warrant any reduction of the water or mud level much below the —22-ft. level reached during the last week in July. As we stated in our article of Aug. 3, the stability of the dam depends upon the resistance offered by the interior stone riprap, which would slide away from the cylinders if the mud now in the cofferdam were removed. It seems, therefore, that any total exposure of the wreck cannot be expected, though the after one-third, which is now in a fair state of preservation, may be floated if desired. All of the explorations in the forward section, where the explosions occurred, can only be made inside of a small cofferdam, which of necessity would have to be so braced that no work other than the separation of the parts by a gas flame could be carried on. In any event the present outlook is that approximately $900,000 will have to be expended to remove the wreck practically piecemeal and to recover the scattered and unidentified remains of a score of seamen. It is improbable that any light will be thrown on the cause of the explosion.

The Irrigated Area of Idaho was 1,428,542 acres in 1909, against 698,718 acres ten years earlier, according to a statement just issued by the Bureau of the Census, Washington, D. C. A summary of the leading statistics presented by the Census for the two years may be of interest to many of our readers, both in itself and as showing the information gathered by the Bureau:

THE IRRIGATED AREA OF IDAHO, 1909 AND 1899.

	1909.	1899.	Per cent. of increase, 1899-1909.
Number of farms in State	30,741	17,471	75.9
Approximate land area of State (acres)	53,313,920	53,313,920	....
Improved land in farms (acres)	[1]2,773,000	[2]1,413,000	96.2
Total value of farm land	[1]$219,346,000	[2]$35,486,000	518.1
Average value per acre of farm land	[1]$41.63	[2]$11.07	276.1
Number of farms irrigated	16,012	9,188	74.3
Acreage irrigated	1,428,542	608,718	134.7
Area enterprises were capable of supplying (acres)	[1]2,284,574	[3]1,345,500	76.8
Area included in projects (acres)	3,547,949	(4)	....
Per cent. of number of farms irrigated	52.1	52.6	....
Per cent. of total land area irrigated	2.7	1.1	....
Per cent. of improved land in farms irrigated	51.5	43.1	....
Number of independent enterprises	3,081	1,834	67.9
Total length of ditches (miles)	12,722	(4)	....
Length of main ditches (miles)	7,821	[5]4,846	57.3
Length of lateral ditches (miles)	4,101	(4)	....
Number of reservoirs	238	(4)	....
Capacity of reservoirs (acre-feet)	1,742,265	(4)	....
Number of flowing wells	61	(4)	....
Number of pumped wells	3	(4)	....
Number of pumping plants	62	(4)	....
Engine capacity of pumping plants (horse-power)	6,727	(4)	....
Acreage irrigated with pumped water	19,825	(4)	....
Total cost of irrigation systems	$40,983,682	5,116,227	701.1
Average cost per acre	[6]$17.18	[7]$3.79	353.3
Average annual cost of maintenance and operation per acre	0.64	0.24	166.7

[1]In 1910. [2]In 1900. [3]Area reported under ditch in 1899. [4]Not reported. [5]Returns for 1899 tabulated incorrectly as 4,977 miles. [6]Based on total cost to July 1, 1910, and area works were capable of supplying in 1910. [7]Based on area reported under ditch in 1899.

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Announcement by Mr. George H. Frost.

For thirty-seven consecutive years—more than the average span of human life—Engineering News has been my close companion. Of extreme feebleness at its birth, its years of precarious existence, its gradual accumulation of strength amid the stress and strain of its earlier years, and its final firmly established place in the intellectual world mark the progress of the Civil Engineering profession and of the construction of the great public works, not only of this country but of the world, during the same period. As in the world of nature great oaks starting from a tiny seed, after weathering the intervening years of storm, have sunk their roots deep into the surrounding earth, so has Engineering News sunk deep its hold in the affections of the noble profession to which it is mainly addressed. I hope to be pardoned if I here express how proud I have been, and am, of this, my contribution to the upbuilding of technical journalism and the advancement of the engineering profession. Words can hardly express my feelings in parting company with something which has been the object of my daily solicitude for so many years.

To the subscribers who in constantly increasing numbers and degree have shown their appreciation of Engineering News, and to the advertisers whose support has made it financially possible to publish a paper of such high quality, I extend my sincerest thanks. Over so long a period and under many discouragements, mistakes have been inevitable. One purpose, however, has been kept constantly in sight—to do the best I knew how and to be of the greatest possible service to the patrons of Engineering News.

Words fail me when I seek to convey a full sense of gratitude to my fellow workers through all the years of the life of Engineering News; not only to those who are in active service now, but to those who have passed out of our ranks through death or service elsewhere. I feel sure that in no enterprise whatever can there be found a more intelligent, enthusiastic and loyal a staff of workers, both in the editorial and business departments, than now transfer their services to the new ownership of Engineering News, and it is a source of considerable satisfaction to myself that I too accompany them, although under different relations, into their new sphere of activity.

Without mentioning individuals, it seems fitting to say a few words of appreciation of the editorial staff of Engineering News. Some of its members have earned international fame, and it is the careful, conscientious, intelligent work of the editorial staff as a whole that has given Engineering News a prestige second to that of no other technical journal in the whole wide world; I say it advisedly.

The new ownership of Engineering News needs no introduction by me; the high standing of its publications and of their chief owner in the world of technical literature and of journalistic enterprise are all sufficient. In these days of cooperation in professional work, and in both industry and finance, I found no other publishers of technical journals to whom I could, with credit to myself and satisfaction to my particular constituency, so safely entrust the future of Engineering News.

GEORGE H. FROST.

As may be gathered from the above statement, the stock of the Engineering News Publishing Co., which has for some years been the property of Mr. Geo. H. Frost, has been sold. The purchaser is the Hill Publishing Co., of New York City, of which Mr. John A. Hill is the chief figure and which publishes the "American Machinist," "Power" and the "Engineering and Mining Journal."

We take pleasure in stating that there will be no change in the editorial policy or management of Engineering News, and that the high standard on which the journal has been conducted in the past will be continued in the future.

Increasing the Efficiency of the Milwaukee Garbage and Refuse Incinerator.

The installation of a refuse incinerator at Milwaukee, Wis., a couple of years or so ago, in accordance with the most recent ideas in the scientific design of incinerators, attracted considerable attention, and still more deserved notability was given to the plant when the results of the acceptance tests were made known. All this was largely due to the fact that the city was wise enough to do what few American cities have done thus far; that is, employ engineers to design the plant and superintend its construction. The city was also wise enough to retain as superintendent of operation the resident engineer in charge of construction, Mr. S. A. Greeley, Jun. M. Am. Soc. C. E., who was selected for that purpose by Messrs. Hering & Fuller, the consulting engineers for the incinerator.

It is one thing to have a plant of this sort show good results on contract acceptance test and quite another to have it approach measurably near to the contract results in daily operation. With Mr. Greeley in charge, the Milwaukee incinerator has done very well indeed, but, probably owing to circumstances beyond his control, there has been opportunity for improvement which none perhaps recognized more fully than did he. Fortunately, the Milwaukee Bureau of Economy and Efficiency came to Mr. Greeley's aid some months ago and with his cooperation showed how material reductions in unit costs of operation might be effected.

The Bureau has issued a pamphlet report on these tests, which bids fair to be of great value not only to Milwaukee but to other cities having or proposing to build incinerators. Elsewhere in this issue we give some of the most interesting of the information presented in the report. Some of the recommendations of the Bureau were put into effect before the report was published, and we trust that the city authorities of Milwaukee will carry out the other recommendations, even though they do involve an operation which, to many city officials, requires as much courage as submitting to have one's teeth pulled, namely, a reduction in working staff.

Efforts to Secure Honesty and Efficiency in Municipal Government at Chicago.

Honesty and efficiency in the administration of municipal affairs and the work of local governing bodies is too frequently at a discount, both in large and small cities, but of late there has been a public movement which bids fair to bring these assets up to par. For a long time the city of Chicago has been undesirably prominent as an example of bad local government, though probably it is not worse than many other cities. In the past few years, however, it has become prominent also on account of the vigorous steps that have been taken to eliminate graft and inefficiency, to free the local government departments from political control, and to put the city on a higher plane of civic morality. Elsewhere in this issue we publish particulars of the work of two organizations in this direction, one of these being an official commission appointed (more or less perforce) by the city council, and the other being an unofficial bureau organized by the leading public-spirited citizens to continue the work originated by the commission. It is of interest to note that here, as in some other cases, engineers have been active both in the organization of the bureau and in its work of investigation. The Chicago conditions are so clearly stated by Prof. Merriam that we need do no more here than to call attention to his article, and to point out that it is not simply an exposure of Chicago methods but of methods which unfortunately are very widespread. The case is bad enough in that city, but the conditions apply to many other cities. It is certainly to be hoped that the aggressive and constructive work of the Merriam commission and the Bureau of Efficiency will be effective in making some radical and permanent improvements in the local government methods of Chicago and other cities.

Bureaus of Municipal Research and Efficiency.

The efforts made at Chicago to increase municipal efficiency, first by municipal officials themselves, led or goaded into action by Prof. Merriam as a member of the city council and later as taken up by a voluntary private organization, raise some interesting questions as to which of these two general plans is most likely to give continued success.

As many of our readers know, a Bureau of Municipal Research, supported by private funds, has been in existence in New York City for a number of years and has not only aided in bringing about many reforms in that city, but has served as an example for similar organizations and efforts elsewhere. These bureaus, like the new Chicago Bureau of Efficiency, are purely voluntary and have no official status and no power whatever over city officials further than those pertaining to the inherent rights of any citizen to inquire into and throw the light of publicity upon municipal methods and urge needed reforms. Such bureaus suffer from the disadvantage, when they attempt to cover many lines of municipal activity, of not being in possession of detailed knowledge and practical experience in many of the lines of work which they attempt to investigate and reform. They have the advantage, so far as gaining the public ear is concerned, of being entirely dissociated from the city government, thus having no political lives to save or to lose, either on their own account or that of their friends, as have in greater or less degree city officials themselves.

Bureaus of municipal efficiency which are official in their origin and supported by the public treasury have possibilities which are shared in relatively small degree by private bureaus. Municipal bureaus, when well organized and conducted, can bring the whole strength of one or more departments of municipal government into their service. Moreover, when such bureaus are in harmony with the city government as a whole, the recommendations which they make as a result of their investigations come home to the

other municipal departments concerned in a way that is far different from recommenadtions made by voluntary private organizations.

The Chicago Commission on Municipal Expenditures was more or less accidental and wholly ephemeral in character, although there is reason to believe that it will produce lasting results. Even though a city establishes what is intended to be a permanent efficiency bureau, it, also, may prove to be ephemeral, since the next change of administration may deprive it of appropriations, if not bring its very existence to a close.

Once an official municipal efficiency bureau becomes thoroughly established and gains the confidence of the public, there is reason to hope that, notwithstanding the dangers of partisan politics and the powers of corruption, it may continue in existence for a long time and do much useful work. The most promising bureau of this character now in existence and, in fact, the first and only one ever established, so far as we know, is the Milwaukee Bureau of Efficiency and Economy. An outline of the work of this bureau was given in Engineering News of March 30, 1911, and reference to it is made, both in our current editorial pages and in the article on the Milwaukee incinerator elsewhere in this issue. Beside a well-conceived and comprehensive plan of action, this bureau has the very great advantage of the advice and assistance of a considerable number of consulting experts in various municipal fields. Among these are a number of eminent engineers and sanitarians. It is to be hoped that the work of this Milwaukee Bureau may continue for many years to come, both on account of the valuable results which it promises to give, and because it will afford an opportunity to test the relative value of official and unofficial organizations designed to increase municipal honesty and efficiency.

Finally, the real test of bureaus of municipal research and efficiency, whether public or private, is the effect they produce upon the municipal government with which they are concerned. This means cooperation rather than coercion. We hope to see continued cooperation between the public bureau and the city officials at Milwaukee and cooperation between the private bureau and the city officials at Chicago.

The Duty of Water in Irrigation.

At this time when the prevention of waste of water used for domestic purposes is receiving attention from such of our cities as have come to a realization that water-supply is not inexhaustible, it is noteworthy to see that a beginning has been made towards the prevention of waste in that other great field of utility to which water is put by mankind, namely, in irrigation.

Mr. Don H. Bark, in a paper read before the Idaho Society of Engineers (abstracted elsewhere in this issue), has emphasized the necessity of water-waste prevention, and of a scientific utilization of the water which is supplied to the settlers at the cost of many millions of dollars. He has pointed out why the present system of contracting for water rights, which calls for a continuous flow, and offers no inducement to the farmer to be economical in the use of water, is radically wrong. As long as such contracts are in force settlers will demand water whether they have actual need of it or not. He believes that water rights should call for a definite quantity, such as so many acre-feet per acre, and that such an amount as will give the best results from an economic standpoint can be determined fairly closely for different localities and different soils. Such a course would most undoubtedly do away with many lawsuits, and would serve as a basis for the courts in the adjustment of water-right cases.

Such a subject is so closely related to the work of the irrigation engineer that it cannot fail to be of general interest to the engineering profession as a whole. It is also exemplary of the progress which is being made in reducing agriculture to a scientific basis, and placing it more and more within the sphere of the engineer.

The Different Iron and Slag Cements.

On another page of this issue we note the recent decision of the Prussian Minister of Public Works officially recognizing on an equal basis with Portland cement, a Portland cement treated, after calcination, with ground blast-furnace slag. This latter product is known in Germany as "eisenportlandcement," or iron-Portland cement, and in England it quite frequently is referred to as slag cement. There are, however, at least four different types of calcareous cement in which either iron or slag play a part in manufacture or composition, so that there evidently is apt to be some confusion as to what precisely is meant when an iron cement or slag cement is referred to. It may be of assistance in clearing up this confusion to differentiate here between the various types.

The four kinds of calcareous cements in which iron in one form or another is concerned are high-iron Portland cement, true Portland cement made from a blast furnace slag base, slag cement and Portland cement with a ground slag admixture.

The ordinary Portland cement is the product obtained by finely pulverizing clinker produced by burning to semi-fusion an intimate, artificial mixture of finely ground calcareous and argillaceous materials. There is some variation in its composition, but in general it contains about 20% of silica (SiO_2), 10% of alumina plus ferric oxide ($Al_2O_3 + Fe_2O_3$), 65% of lime (CaO) and 5% of other salts. The ratio of the alumina to the iron oxide ranges from 6:1 to 1:1, though generally falling between 2:1 and 3:1. Some years ago it was announced that a Portland cement containing a higher percentage of iron than of alumina, would better resist the attacks of the salts in seawater, and accordingly manufacture was started in various places of the so-called "high-iron" cements. These, according to Eckel, may be subdivided into "ferro-Portlands," containing appreciable percentages of alumina, with the iron oxide-alumina ratio ranging between 1:1 and 4:1; and "ferrite cements," containing little or no alumina, the iron oxide-alumina ratio exceeding 4:1. Except for the relative changes in the iron and alumina content these cements are the same as the regular Portland cement in composition, though they are somewhat different in behavior. In manufacture the iron is obtained from one kind or another of iron-bearing ores or sand. In Germany these cements are known variously as erzcement and kraftcement, and have become best known through the efforts of the late Dr. Michaelis to further their use.

The Portland cement made from blast furnace slag as a base is a true Portland cement, the only difference between it and any other kind being that the ingredients are taken largely from an artificially prepared slag instead of from a natural rock or earth. This slag, the by-product of iron furnaces, consists essentially of lime, silica and alumina, the three main constituents of Portland cement, with only traces of iron oxide, so its usefulness in the manufacture of Portland cement is obvious. Portland cement so made should in no way be confused with any type or kind of slag cement or iron cement. One of the largest producers in this country, the Universal Portland Cement Co., manufactures its cement in this manner.

Slag cement proper is not a fused material, but is the intimate mechanical mixture of slaked lime and granulated blast-furnace slag, both materials being pulverized before, during or after mixing. It is a member of the pozzulanic group of cements and is not widely used either in this country or abroad. Like natural cement, slag cement is inferior to Portland cement in strength and wearing qualities, is lighter in color and in weight and is normally slower in setting.

The fourth type of the so-called "slag-cements," the kind about which the discussion in Germany has raged, bears a family resemblance to the one mentioned immediately above. It is formed by adding to the ground Portland cement clinker, prepared as a true Portland cement, up to 30% of pulverized slag. This has been the p... tice in Germany by some makers for some y... s, it being claimed that the addition of a mate... containing silica in an active form was high... neficial to the cement. On the other hand, ther... s a decided feeling against the practice among... tain Portland cement makers, with the r... noted in the article referred to. The addin... a pulverized slag to the Portland cement ... er has not had any vogue in the United Sta...

We have then a high-iron cem... a species of Portland with high iron content, ... slag cement which is merely a mixture of uni... ed material; a true Portland mixed after burni... with a pulverized slag, the mixture being k... n abroad as "eisenportlandcement," but not di...nguished by name in this country; and a true Portland which uses slag as a basis for its ingredients. The four should be kept separate in the mind, though the complications of nomenclature in different countries cannot but add to the confusion.

A Newspaper's Idea of Slag Cement.

The well-known tendency of the daily newspaper to go wrong on technical matters finds a fair field in this subject of slag cement. We have before us a clipping reported to be from the Louisville "Courier-Journal." After reading it we can only conclude that the exigencies of the liquor controversy in his beloved state must be taking too much of Marse Henry Watterson's time from his editorial duties. The clipping reads:

> It really seems as though nothing were worthless, if men only knew how to use it. The blast furnace affords an illustration. Stone is lighter than iron, and hence will float upon it like oil on water when both the stone and the iron are melted in a furnace. Some of the stone which rises to the top becomes slag. For years millions of tons of slag were thrown away or used to fill up gullies on vacant land. But at last a use was found for it worth while. It is thrown while white hot into water, and is at once without further ado changed into Portland cement. As cement was never so much in demand for all sorts of purposes as to-day, it is fortunate that this very cheap way of making it was discovered. The man who first learned to do the trick deserves a monument more lasting than bronze.
>
> Why not a concrete monument? It would be so eminently fitting.

Harbors and Harbor Engineering in the United States.

A branch of engineering work which as yet has furnished but few opportunities and limited scope for engineers in this country is that of harbor engineering. Three reasons for this may be cited: (1) the lack of systematic public administration of our ports and their commerce; (2) the comparatively simple character of the works which meet the requirements under the conditions of small tidal range on our coasts, and (3) the frequency with which old and inadequate facilities are permitted to continue in service in spite of their inefficiency and lack of economy. The foregoing remarks apply to a port as a whole (inclusive of its harbor proper), but independent of the means of approach from the sea. As appropriate to a consideration of the general subject of port and harbor development we quote the following statement from a report* on European ports submitted to the Canadian Minister of Marine in 1908:

> The striking features of British and Continental construction are permanence and continuity of purpose. Though the work may be carried on over a large time period, the whole is the result of a complete original plan or leading idea carried out by sections as the demands of the business warrant. Time is taken to carefully consider and prepare complete plans.
>
> In the later development of modern ports no small attention has been given to the artistic

*Report on British and Continental Ports, with a view to the Development of the Port of Montreal and Canadian Transportation; by George W. Stephens, President, and Frederick W. Cowie, Chief Engineer of the Harbor Commissioners of Montreal.

effect of the completed scheme. In many cases it has been possible to provide recreation areas, in the shape of broad and spacious promenades for the people, without in any way interfering with efficiency.

Designs are made with a view to future extensions. The more successful ports (as Liverpool, Hamburg and Antwerp), with courage and confidence in the future, provide for anticipated trade. As a result they are the leaders in progress. The more successful ports keep their development ahead of the demand and so capture the trade when it comes.

The engineering profession, through the importance placed upon its integrity and high standing, and the remuneration it commands [in this line of work] has attracted to it men of commanding ability and executive skill. They study not only the technical features, but they qualify themselves for expert executive advice and take prominent part in the councils of commercial and corporation boards. The improvement of rivers, in all its branches, and as a rule the maintenance of docks, are done departmentally (that is, by the officers and men of the port authorities). In Liverpool and Glasgow, where continuous development has evolved an experienced staff and efficient plant, most of the dock construction is also carried out departmentally.

As a rule, sheds, equipment and work of a special nature are done by contract. As a general rule, large works are constructed more rapidly by high-grade contractors, but this method does not lend itself to modifications due to experience gained as the work progresses, and most engineers claim that when they put in the work themselves they know what they are getting.

For contract work, bids or tenders are invited from firms of known integrity only. The lowest tender is not by any means always taken, and great consideration is given to the contractor's record, to the work he has in hand, to the program he can put forward, and to his organization and plant for the work. The standing of contractors is very high. Owing to the fact that the lowest tender is not considered of more advantage than the one best equipped for the work, sound firms remain in the business and continue for generations. They ask for prices to make a profit, and their prices being so much per unit there is very litte question of extras. If the work is enlarged they usually continue it without question, asking and obtaining such increase as is fair under the circumstances. They have on their staffs high-class engineers, and the relation between the engineers and the contractors is more easily maintained from the fact that the class of their work is high and there is little cause for friction with regard to extras or overtime.

The ports that are doing the biggest business and doing it most efficiently are the ports that have kept their facilities ahead of actual requirements. The ports that have remained stationary or have lost in prestige have been those which neglected to provide facilities before business was forced to seek elsewhere the same facilities provided by rival terminals. Business follows the facilities.

Unity of authority, concentration of business, depth of water areas, and facilities for despatch of business are the prominent characteristics of successful port administration.

During the past few years much has been said and written in regard to the failure of American ports to make such improvements as would tend to develop their shipping trade and would meet modern requirements for the accommodation of this trade with efficiency and economy. The improvements of the first class include navigable areas, piers, docks and wharves suitable for steamers of large size. Those of the latter class include cargo sheds and freight warehouses, railway connections, and means for the convenient and economical handling of freight between ships, sheds and cars. The outer works and means of access (from the sea or lake), such as breakwaters and deep-water ship channels, are provided by the federal government, with assistance from State and municipal authorities in some cases, as for the formation of a deep channel through the harbor proper. The design, construction and maintenance of these works are in the hands of the U. S. Engineer Corps.

But the accommodations for ships, the handling and transfer of freight, the warehouse accommodation and the railway facilities are matters for local authority. The provision and control of these works, however, are often distributed among various authorities and private interests. With such a dispersion of authority and responsibility, progress is hampered both by inertia and friction; consequently there is no unity or harmony of action, while great difficulty is experienced in the formulation or acceptance of any definite policy or line of action, as well as in the initiation of any work of improvements.

In his report on "Water Terminals,"* the U. S. Commissioner of Corporations (Mr. Herbert Knox Smith) has called attention to the fact that two factors particularly tend to cause the backward condition of our ports: (1) their water frontage is, as a rule, largely under the control of private interests; (2) the value of the approach channels formed at great expense by the federal government is sometimes neutralized by the action or inactivity of local authorities in regard to terminal accommodation for shipping and commerce in general. Mr. Smith made the very wise suggestion that the government should undertake these costly channel improvements only upon the condition that the locality benefited agrees to furnish adequate public terminal facilities. In this report it is stated that public control exists in considerable degree only at New Orleans, San Francisco, Baltimore and New York, while at the last place it is greatly modified by exclusive private leases for long terms. Out of 50 of the present ports (including those on the Great Lakes) only two (New Orleans and San Francisco) have practically complete public ownership and control of their active water frontage.

Where a railway or other private concern owns an important frontage upon a harbor, it is naturally inclined to utilize and develop this for its own exclusive interests, and to give little if any consideration to its relation to the development of the harbor as a public utility. Nor are private concerns at all inclined to permit the use of its facilities by other and competing concerns, whereas it is to the interest of the port to have adequate facilities furnished to all comers without discrimination. If an improvement on the privately owned frontage should be needed as a matter of public benefit, but would not be of particular benefit to the private interest, it probably would not be undertaken. Furthermore, if public development of the harbor facilities should include improvements calculated to benefit interests rival to the one in question, the latter would naturally make strong opposition to these improvements. Such conditions constitute a case of what is known as adverse ownership. On the other hand, where a public authority has control (more or less) over a harbor whose water front is owned largely by private interests, there is little incentive to the development of the harbor and great difficulty in devising any large or comprehensive scheme of improvement in the public interest.

Thus at Boston, the present facilities for ocean steamers are owned mainly by the railway companies, and the accommodations provided were for years far below what was needed. Now one of the companies has built greatly improved facilities, but of course the location and arrangement of these were determined by the location of the company's property and not by consideration of the interest of the port or the convenience of the shipping companies. At the same time the State is developing public facilities in an entirely different part of the harbor, and it is easily possible that eventually these may supersede the privately owned facilities built at large expense. It is quite evident that in such a case as this it would have been much better to have one authority, and that a public authority, in entire control of the situation and the expenditures. Probably more progress would be made by our seaports if there was an important American merchant marine, with numerous and powerful shipping companies to demand recognition. As it is, the demand comes more or less indirectly, and in part on behalf of foreign concerns.

We may perhaps contrast our rather limited work in this branch of engineering (excepting always that done by the government under the direction of the U. S. Engineers) with the very extensive and comprehensive work of practically all European ports: Liverpool, Glasgow, Bristol, Southampton, Manchester, Hamburg, Antwerp, Havre, etc., are all striking examples in this line. It is true that London, the greatest port in the world, has not kept pace with others, but this is because its water front and its docks have been in the hand of numerous and rival competitive private interests. However, with the recent acquisition of all these properties by the city, and the creation of a single organization to have entire charge, a general scheme of improvements on engineering and commercial lines has been inaugurated.

One great defect of American ports is lack of public control and of concentrated authority for such control. Private interests have control disproportionate to their relations to the public interests in the port. Public interests are served, too often, by a number of bodies more or less diversified, acting independently, and not infrequently subject to political control. The control of the port as a public utility may be in the hands of the city, of a special board or commission, or of the State. At both New Orleans and San Francisco (the only ports having public ownership and control of their water fronts) the control is in the hands of a State commission; the same system exists at Boston, but in this case the present water front is mainly privately owned, and the State is developing a policy of providing publicly owned facilities on made land. The Canadian government has recognized that a port is not merely of local importance but rather of national importance, and for this reason it has for many years assumed control of the management and improvement of the harbor of Montreal and its approach from the sea, with satisfactory results to all interests. State control exists in France also, but here there is often complaint at delay in providing the necessary improvements, partly owing to the amount of "red tape" involved and partly no doubt to the fact that the government has to consider all the ports, while each individual port considers that its claims should have precedence. However this may be, it may be noted that a very comprehensive scheme of extension of the port of Havre has been authorized, requiring very large and costly engineering works.

At Liverpool, Glasgow and London, the entire control is in the hands of special port commissions which control all functions relative to facilities, improvements, pilotage, port charges, etc. At New York and at Bristol (England) the city government exercises direct ownership and management. At Manchester, the works are owned and operated by a company, but the city has large representation in the company, owing to its financial support of the enterprise which built the ship canal and thus created the port.

Inland seaports situated upon or above the tidal portions of rivers are more common abroad than in this country, and in many cases they are ports of no small importance, even when established on comparatively small streams. Many of them are river ports also with an inland waterway traffic which is auxiliary to the ocean traffic. Where the streams are relatively small, the increasing size of ocean steamers naturally involves difficulties in providing a navigable channel suitable for the handling of vessels; and in addition to this the river itself may present difficulties due to floods, silting or other influences. Nevertheless, several ports have been brought to great size and commercial importance in spite of these limitations. Notable instances of this kind are Glasgow on the Clyde (in Scotland) and Newcastle (and adjacent ports) on the Tyne (in England). In this country, however, most of our seaports are in land-locked bays or on large rivers where wide and deep channels can be provided without much difficulty.

In considering the questions of harbor development and rail-and-water terminals, we must deal

*Report of the Commissioner of Corporations on Transportation by Water in the United States (Part 3, Water Terminals); U. S. Department of Commerce and Labor, Washington, D. C. Eng. News, Oct. 6, 1910.

with the commercial conditions as well as with the engineering features. This is necessary, since the establishment of facilities for the development and improvement of a port involves very much more than the design and execution of the individual engineering works. In fact, these works are simply the means to the end of furthering the commercial prosperity of the port. The harbor engineer, however, must study and have a familiar knowledge of these important features which have a governing influence upon the technical part of his work. This is indicated in the Canadian report which we have quoted.

There is not necessarily any direct relation between the commerce of a port and the facilities which that port affords. The establishment of a port and of harbor facilities does not result necessarily or of itself in the development of business, although this point has been overlooked in some cases. It is a difficult matter to attract new trade to a port, or to attract any important trade to a new port (even when there is good promise of business), for the reason that established trade routes and steamship lines are not easily diverted. For this reason, the commerce of many a port continues to grow in spite of failure of the authorities to provide improved facilities commensurate with this growth. Nevertheless, this is no good reason for such dilatory action on the part of the authorities, since the general evidence points to the conclusion that the port which is progressive in providing modern facilities is the one which finds its commerce increasing.

On the other hand, if a port offers facilities in advance of what are needed for its commerce, and expects the steamship companies to develop business, it will find that it is working on a wrong hypothesis. Steamship companies exist for profit, and will send their steamers wherever there is business, even if the port offers only an anchorage, and freight must be handled by boats and lighters. This aspect of the case has been stated very plainly in a report of the Massachusetts Board of Harbor and Land Commissioners (1910) in regard to the proposed development by the State of a great shipping and railway terminal on lands acquired for this purpose at East Boston:

> The building of piers 1,200 ft. long with 35 ft. of water in the berths does not necessarily bring large steamships to the port. There are now unused piers at this port. Steamships will come here if there are passengers and cargoes. The citizens of Boston must develop the business, the manufacturing and the commerce of Boston, Massachusetts and New England.

When the Manchester ship-canal was built, converting the inland city of Manchester (the center of a great manufacturing district) into a seaport 30 miles from the coast, it was recognized that the development of the ocean or over-sea shipping trade would be slow, due to inertia in commercial affairs. And this in spite of the fact that there was a great trade to be handled and that elaborate modern facilities had been provided. Local interests undertook, therefore, to help this development in two ways, of course with a view to their own profit: (1) Steamship lines were established having Manchester as the home port, for where one ship goes another will follow, and where one line finds business others will try to secure a share. And each steamer is a powerful advertisement for the port. (2) Great efforts were made to increase the importance of Manchester by securing additional local industries, which would incidentally develop both import and export business. The most conspicuous feature of this movement was the acquisition of a very large tract of land adjacent to the canal, and the establishment thereon of a number of important manufacturing concerns. And the port authorities have been active in improving their facilities to keep pace with the growth of business.

It is to be noted also that ports have different commercial characteristics: some have both passenger and freight traffic in important (but varying) proportions; others have mainly freight traffic, and a few have mainly passenger traffic. Among these last may be mentioned Dover (England), which has a large continental traffic and is also a port of call for important lines of ocean steamers. This port, it may be noted also, has few natural advantages and has been artificially created, in the main, by enclosing a large area of open sea by means of breakwaters. Some American ports which formerly were used almost entirely for freight have developed an important passenger business, and this is notably the case at Boston. Where the passenger business is an important factor, special provision is required for the convenience of passengers at the pier or wharf, and in going to and from the pier.

In another respect also, the engineering features are of secondary importance, and that is in the commercial location of a new port. Many harbor and commercial prospects have come to naught by failure to recognize this condition. It is not difficult to find locations offering great natural advantages, and the engineer for a promoter may find it easy to lay out a very desirable port with exceptionally good facilities. But it is not easy to secure financial or commercial backing for such projects, owing to the grave doubts as to the action of shipping interests in adopting the new ports. The Montauk Point project (Long Island, N. Y.), which has been advocated at intervals for nearly fifty years, is an instance; and another is that (now obsolete) for a great port at Galway, on the west coast of Ireland. Both of these were proposed mainly for passenger service, and in view of their location relative to trade routes it is probable that no amount of natural advantage or engineering skill could make either one of them a commercial success. The port of Manchester, mentioned above, is an instance of quite a different kind. Here the commercial conditions were such as to promise success in spite of the entire absence of natural advantages and the enormous expense and great engineering work necessary to convert this inland city to a port available for ocean steamers. It is to be noted also, that some of the largest and most important ports have been established at apparently unfavorable locations, and have been raised to prominence by a combination of commercial intelligence and aggressiveness with engineering skill. Notable examples of this are the cities on the Clyde in Scotland and the Tyne in England, as noted already.

It may seem that we have strayed rather far from the question of the work of the engineer in harbor construction and development, but we have shown that the engineer has to consider a great deal more than the purely technical aspect of the question. However, we may now touch upon the engineering side of our subject.

One of the first questions is whether to have a closed or open port, and this is determined usually by the tidal range. In this country the variation of water level is so small that little difficulty is found in the varying elevation of the ships' decks or in providing ample depth at low water. In Europe, however, it is very generally necessary to form a closed port, connected with the ship channel or open sea by locks. This has the objection of interfering with the free movements of vessels, a ship arriving shortly after the period of high tide having to wait for several hours in the stream before it can enter the harbor. For this particular reason, the designs for the new extensions for the harbor at Havre (France) provide for an open basin. This is intended for the use of large transatlantic steamers, and it was considered that the advantage of enabling ships to enter and leave regularly, at all stages of tide, and without the delay and danger of handling these big steamers in a lock, would more than compensate for the extra cost of deep foundations permitting ample depth of water for the largest vessels at the lowest tide level. The importance of the question at Havre may be understood when it is stated that the range from maximum high water to minimum low water is about 27 ft. At Southampton, too, there are open basins as well as closed basins or docks. Antwerp has a great length of open river front with masonry walls or quays, but has also closed docks.

Another question is as to the respective merits of piers or basins for the use of ships. In the former case, the vessels lie alongside piers projecting from the shore line or quay and separated by comparatively narrow water spaces or slips. In the latter case, the ships loading or unloading lie at the wharves or quays formed by the sides of a large rectangular basin or dock, while vessels waiting for cargo or orders can be moored in the central space. The former practice [illegible] most universal in this country, while the [illegible] is almost universal abroad. At Manchester, [illegible]ver, there is a combination of these plans, [illegible] piers projecting into large basins. In any [illegible] the depth of water and length of frontage [illegible]d be sufficient to accommodate not only [illegible]gest ships using the ports but also the larg[illegible]ips which may be expected in the future. [illegible]ocks must be provided capable of taking in [illegible]ge vessels for repairs.

In the construction of work of [illegible] kind, foreign practice has been to have m[illegible]more costly and permanent works than in thi[illegible]ntry; here timber has been used freely, but [illegible] is a tendency towards a more extensive [illegible] of masonry. Thus at American ports piers are [illegible] sometimes built with masonry walls and solid [illegible]ing instead of timber pile construction. The [illegible]undation conditions will in some cases be an imp[illegible]tant factor, although it may be said that in E[illegible]pe masonry and heavy construction is adopted [illegible]gardless of foundation conditions, the construction being designed to meet these conditions.

Upon the piers and wharves are usually built freight sheds or transit sheds for cargoes waiting to be loaded on ships or into cars. There is difference of opinion as to whether one-story or two-story sheds are preferable, and the decision rests largely upon local conditions. One-story sheds are most generally used, but for those serving large ocean passenger steamers there is sometimes an upper floor extending the full or part length of the pier. This floor is usually for the passenger accommodations. At Montreal, however, two-story sheds are used on all the new work, the upper floor being for inbound freight and being equipped with traveling cantilever cranes which handle this freight from ship to shed and from shed to cars or wagons. The outbound freight is handled on the lower floor. In some cases, storage warehouses several stories in height are built on the piers or wharves, and such a plan has been proposed for the new shipping facilities needed at Philadelphia. But as a rule the warehouses are quite distinct from the "transit sheds."

Railway connections and facilities are essential to the economic and efficient handling of the business, but at the older ports it is often extremely difficult to find sufficient space for the tracks and switches needed to provide for the existing and growing traffic. The conditions at New York, in this respect, have been discussed in our columns. At Montreal, and at many European ports, such facilities form a part of the harbor equipment, under the ownership and management of the harbor authorities. Not only must the trackage system afford ample communication with the docks, piers, etc., but it must be connected with the various railways entering the port.

This matter of railway facilities is a weak point at many of our ports, and Mr. Smith in his report in "Water Terminals" (mentioned above) states that only seven of our ports have anything approaching a general belt railway. One reason for this lack of such important facilities is that each railway has little interest in providing more than barely sufficient trackage to serve such part of the water front as it owns and controls, while the port authority has no land available for a belt railway or for linking up the various individual railway lines.

Wagon traffic must be provided for, and where passenger traffic is important, there must be convenient means of access for carriages, omnibuses and street car lines. Auxiliary facilities to be provided will include dry-docks and ship repair yards, coaling appliances for steamers, grain elevators, stock yards, railway freight yards, etc.

The lack of freight-handling facilities and machinery is one of the weak points of American ports, especially in comparison with the varied and extensive equipment of this kind in European ports. This condition, however, seems to be due not entirely to lack of progressiveness on the part of the authorities at our ports. In a report to the Montreal Harbor Commissioners, Mr. W. F. Cowie (Chief Engineer) gave as one of the important reasons the difference in methods of providing crews. Most of the vessels using Ameri-

can ports belonging to European ports, and their crews are engaged at the latter for a round-trip voyage. Consequently, at the American port the ship has its crew available to handle the freight without additional expense. On arrival at the home port, many of the crew are discharged and a new crew is not engaged until the ship is ready to sail. Should the American merchant marine regain its importance, the problem of handling ship cargo at our own ports would assume a rather different phase. The system of employing crews, however, is not the sole or sufficient reason for failure to provide necessary facilities.

The solution of the problem of freight-handling machinery or facilities is being made more insistent by the increasing demand for the handling of goods rapidly and with a minimum of damage. Hoisting freight from a ship by slings and landing it on the pier to be handled and rehandled in small units by trucks and wagons is not only slow work, but involves many chances of loss and damage and delay. With many special forms of dock cranes and transporters, the freight may be handled in large lots and delivered directly to a storage floor or loaded directly on cars, wagons, lighters or canal boats. Mr. Cowie points out that the demand for speedy and safe delivery is an important and increasing incentive for the introduction of methods of mechanical handling of freight. Another incentive is the reduction in cost of handling effected by such methods, and where great quantities of freight are handled a very small reduction per ton will make a very appreciable saving in the year's work. This question has been discussed already in our columns and need not be enlarged upon at this time.

In regard to improved facilities it may be said that it is easy to lay either too much or too little stress upon their importance. On the one hand, it may be assumed that to provide them will or must lead to growth of trade. On the other hand, it may be assumed that as existing trade gets along without them they are not really needed. Such assumptions are not logical nor of universal application; established traffic will continue under difficulties, but may readily expand when better facilities are not provided. But business is the prime essential in any and every case.

The report by Mr. Smith on "Water Terminals," to which reference has been made already, lists five prime factors for good water terminals: (1) harbor organization, (2) wharves and piers, (3) warehouse space, (4) transshipping or freight-handling machinery, and (5) belt line railway connections between the water traffic, the railways, and (if possible) the local industries. On the basis of his investigation, which covers not only seaports but also inland navigation and river and lake ports, he presented five conclusions: (1) terminals are as important as channels, (2) our harbors have not developed their terminal frontage, nor are they properly organized or controlled; (3) railways largely control water terminals, often to the disadvantage of general water traffic; (4) there is practically no linking up of the rail and water systems at the water front, but rather the opposite tendency; (5) localities or ports have little cooperation with the federal government which improves their channels.

It will be evident that under the conditions now existing, and which we have outlined above, there is at this time comparatively little scope for the American engineer in the broad lines of harbor design and development. The engineer for a company owning a certain water front may be required to plan for developing or utilizing this property; but he will have to do it within limits prescribed by property boundaries and on the narrow lines of private interests and individual facilities, rather than on the broad lines of the best location and arrangement of facilities to benefit the harbor and the commercial port as a whole. At the same time, the engineer for a harbor authority may be equally unable to follow out these broad lines of policy, owing to limitations imposed by private ownership of important parts of the water front and the harbor. There are exceptions to these conditions, it is true, but it is to be hoped that the conditions themselves will become exceptional.

LETTERS TO THE EDITOR.

The Use of Sulphur in Embedding Metal in Stone.

Sir: I have read with interest both your abstract and the original article by Mr. G. Denil on the destruction of masonry by embedded and attached metal (Eng. News, Aug. 24, 1911, p. 232). It is a matter which I have had in mind for some time; in fact, I had intended to get together just the same sort of information from American practice.

I cannot agree, however, with some of his conclusions, my observation being that sulphur is particularly bad and not only eats the iron or steel, but also the stone. I have especially in mind the cast-iron fence surrounding the Oak Hill Cemetery in Washington, D. C., which shows an example of sulphur filling in which the cast-iron posts are badly eaten and also the supporting granite stones. These latter are rounded, all corners being entirely effaced, and the disintegration has taken place more on the south, or sunny, side than on the north.

W. J. Douglas.

60 Wall St., New York City, Aug. 30, 1911.

Anti-Typhoid Inoculation Recommended to Field Engineers and Contractors.

Sir: With the exception of the army, I suppose there is no one body of men more frequently exposed to the disease of typhoid than engineers in the field. Conditions usually found on construction work away from a civilized community all tend to unsanitary conditions and it is not infrequent that an epidemic of typhoid is the result.

In view of this fact I believe many of your readers will be glad to know of the protection which may be secured by being inoculated against typhoid. It is only recently that this inoculation has been used in this country—being first introduced into the Army, and the figures from that source are of decided interest.

"Modern Treatment," by Hare, published late in 1910, states that

> anti-typhoid vaccination is now being carried out among the enlisted men of the United States Army. The work was begun in February, 1909, and a recent report shows that 1,400 have been immunized. With one exception, no case of typhoid has occurred among those vaccinated. On the other hand, 135 cases of this disease have been reported among the 75,000 enlisted men since the introduction of vaccination.

A medical journal of recent publication states that

> during the Spanish-American War, there were 20,737 cases with 1,586 deaths, and all within 3½ months. One in six had the disease and of those regiments left in the United States, one in five.
>
> Among the 18,000 men mobilized along the Mexican border during the recent maneuvers, all were immunized by inoculation and after 2½ months of camp life no cases had developed except one teamster, who, it was found, had not been inoculated.
>
> English army statistics demonstrated that the ratio of uninoculated to inoculated men who contracted the disease was 7 to 1 and of deaths 11 to 1.

These figures seem to indicate that the anti-typhoid virus is doing in its field what smallpox vaccination has done to stamp out that dread disease.

During a recent typhoid epidemic in a construction camp, the writer, with nine others, was treated with the virus. None of us felt any ill effects from it, with the exception of one man who suffered from a severe headache for a day. The method of application is very simple, the virus being introduced into the arm with a hypodermic needle.

Yours truly,

Albert A. Northrop,

Assistant Auditing Engineer, Mississippi River Power Co.

Keokuk, Iowa, Aug. 19, 1911.

[Those who wish to pursue this subject further may find an interesting article entitled "Anti-Typhoid Inoculation in the American Army," by Major Frederick F. Russell, Medical Corps, U. S. A., in the "Journal of the American Public Health Association" (Urbana, Ill.) for July, 1911.—Ed.]

The Design and Construction of Waterproof Concrete Tanks.

Sir: The excellent report of Mr. Hiram B. Andrews as abstracted in Engineering News, July 27, 1911, p. 122, suggests many points of interest in connection with the construction of waterproof concrete structures. The experience of Mr. Andrews in the construction of reservoirs at Waltham, Manchester and Lisbon Falls is exactly the same as that of many engineers who have come in contact with this class of concrete construction. Many cases will be recalled where leakage has taken place between sections of a concrete wall put in at different dates, as on the following day or at least with intervening time sufficient for the concrete to have taken its final set. One case in the writer's experience is particularly interesting. It is a circular storage reservoir built to store water for a small city in Rhode Island. One of the largest and most noteworthy construction companies in America did the work. A great deal of care was taken to grade the aggregate so as to give the densest possible concrete, and equally as much care was taken to brush away all laitance from the surface of the concrete in the forms before placing fresh concrete at the beginning of each pour. In spite of this care it was possible after a few months to determine each day's pour, by the wet bands which occurred when the day's work was finished. At some divisions these extended entirely around the tank. At places the leakage was considerable, and sufficient not only to make the tank unsightly, but to cause a considerable loss of water.

It is the observation of the writer that this type of leakage does not diminish with time, as in the case where it is caused by seepage through a porous wall. When a rich mixture is used and apparently all possible precautions are taken to produce a good job, the divisional lines between the successive pours are more troublesome. In Engineering News, July 6, 1911, p. 26, there is an article by Prof. Alfred H. White which indirectly shows the cause of the trouble. This article shows by the results of many tests and deductions the shrinkage of concrete while setting in air even though reinforced with steel. In Chapter III of "Reinforced Concrete," by Considére, the matter of shrinkage of concrete while setting in air is taken up. The following is quoted by way of explanation:

> In prisms made of neat cement with iron rods tying the blocks together * * * * and preventing shrinking in the vertical direction, the joints opened so much as to become visible to the naked eye. * * * * When the reinforcing rods prevent shrinking and do not cause cracks as in the case with common concrete the stresses and changes due to the shrinking cause a decrease in elasticity, resistance and capacity for elongation before rupture. * * * * These unfavorable changes in concrete increase with time during several months.

The observations of Considére are as a whole corroborated in the article by Prof. White. The best experiments show conclusively that when a mass of concrete hardens in air, it shrinks from 0.02% to 0.05%. As the mixture is made richer the shrinkage increases in amount as well as rapidity.

In pouring the concrete for a standpipe, a section of equal depth is poured around the standpipe each day. The section poured one day becomes hard before the section for the next day is put in place. The concrete put in place the second day begins to set, at the same time gripping the reinforcement. When deformed steel rods are used the bond of the concrete to the steel becomes strong enough to prevent the mass from settling down as it shrinks, leaving an opening between the sections of different age. This opening will increase in width as the hardening of the concrete progresses. If water is put into the standpipe within a month, the sections will perceptibly swell and in some cases will close the cracks. When water is put into the standpipe and the horizontal reinforcement is put under a stress of 12,000 to 15,000 lbs. per sq. in., the rods near the bottom of the tank elongate, increasing the diameter of the tank or else putting a tremendous shearing force into the concrete. This shear will tend to make the concrete open along vertical lines on the outside of the tank and because the elongation of the steel is zero at the top the horizontal shear decreases in intensity from the bottom toward the top. This will bring extra strain on the weak horizontal joints which form the divisional lines between the different pours. This difficulty could be obviated for the most part by increasing the amount of reinforcement, which will decrease the elongation of the steel at the bottom and leave the standpipe in more nearly its original form.

To prevent leakage through horizontal joints, grooves are formed in the surface of the concrete at the close of a pour for the purpose of receiving the section above. This causes the water to pass through a greater distance in order to reach the outer surface, consequently decreasing the volume of leakage. However, the most satisfactory method of overcoming the difficulty would

be to use copper strips from 4 to 6 ins. in width, bent at right angles on both edges ½-in., and with a small V-crimp in the center. (Fig. 2.) After finishing and leveling up the day's pour these strips should be pressed into the fresh concrete one-half their width with end joints lapped from 3 to 6 ins. so as to form a continuous vertical strip of copper entirely around the reservoir. This metal band will last indefinitely in the concrete and completely cut off leaks which might take place otherwise. This makes a joint in the standpipe similar to that used in the construction of several types of water pipe.

The design of a reinforced-concrete standpipe will require consideration of the hoop tension set up in the horizontal steel, the compression stress due to the weight of the concrete, and the stress due to the wind pressure on the standpipe. One fundamental principle in the design of all masonry structures is to so proportion the structure that there will be no tension in any part of the masonry. Recently it has become common practice to abandon this timeworn principle and use such high stresses in the steel that cracks will occur in the concrete before the steel has reached its intended stress. If unit stresses between 10,000 and 20,000 lbs. per sq. in. are allowed in the steel, the stress in the concrete immediately surrounding the steel will vary between about 1,000 and 2,000 lbs. per sq. in. Most of the concrete ordinarily put in such structures will crack before these high-unit stresses are reached. In order to have the steel and concrete act together, the unit stress for the steel and concrete ought to be proportional to the moduli of elasticity.

Let p = unit stress in steel,
E_c = modulus of concrete,
E_s = modulus of steel,
C = unit stress in concrete.

Then $p : E = C : E_c$

$$p = \frac{E_s}{E_c} C.$$

The above equality will hold until the concrete cracks. In cases where it is not necessary that a waterproof job be done the small cracks along the sides of the tension rods would do no harm, in fact, a recent article in Engineering News showed a case where reinforced-concrete girders stood their designed load even when the concrete was completely loosened in the center of the beam and for some distance each side of the center, by electrolysis. Just how much these cracks amount to in the standpipe can best be judged by assuming a rod circling a given standpipe and stressed to a certain specified unit stress. Suppose the rod is embedded in a 30-ft. standpipe wall and has been stressed by the pressure of the water to 15,000 lbs. per sq. in. The elongation of the rod may be computed.

$$E_s = \frac{\text{stress per unit area}}{\text{deformation per unit length}} = \frac{p}{d}$$

Assuming E_s to be 30,000,000,

$$p = 15{,}000,$$

$d = 0.0005$ per in. of length. The factor 0.0005 gives a total elongation of 0.567 ins. or ½-in. more than the concrete surrounding the rod would elongate. This leaves ½-in. to be taken up by cracks in the concrete. If the concrete were a homogeneous mass it is probable that this ½-in. would be taken up by many invisible cracks; in fact, so small that leakage would not take place. As a matter of fact the concrete will vary a considerable in elasticity. This will cause the cracks to concentrate about the areas of low elasticity and consequently be much larger.

It is evident from the above that a unit stress for steel much smaller than 15,000 lbs. per sq. in. should be used. If 7,500 lbs. per sq. in. is used the excess of elongation of steel over concrete will be imperceptible in standpipes less than 50 ft. in diameter.

Let d = average distance from a given section to the top of tank.
Let H = the total hoop tension in the above section.
r = radius of the tank.
g = unit weight of fluid in the tank.
n = width of section or zone.
$2H = 2\,dgrn$, $H = dgrn$.
Let A = total area of steel in the section and p equal the safe unit stress as before.

Then $\ldots\ldots\ldots\ldots\ldots\ldots Ap = dgrn$

And $\ldots\ldots\ldots\ldots\ldots\ldots A = \frac{dgrn}{p}$

As long as the concrete is supposed to act with the steel, and to properly protect it, p should not be greater than 7,500 lbs. per sq. in. The standpipe should be divided into several zones and the amount of steel for each zone determined from the above formula.

The stress in the walls of the standpipe due to the winds and the stress due to the weight of the concrete will be the largest factors in determining the thickness of the walls. The wind stresses are determined first as follows:

Let P = maximum wind pressure per unit area perpendicular to the direction of the wind.
h = Total height of standpipe.
r = Inside radius of standpipe.
r' = Outside radius of standpipe.
W = Weight per cubic unit of concrete.
S = Unit stress on concrete at the bottom of standpipe due to the wind pressure.

The total external moment due to the wind pressure on the side of standpipe is equal to

$$P\,(2\,r'\,h)\,\frac{h}{2} = P\,r'\,h^2$$

Evidently the effect of the wind is to produce a tension on the windward side and a compression on the opposite side. Equating the above external moment to the internal resisting moment there results:

$$\frac{\pi\,s\,(r'^4 - r^4)}{4\,r'} = r'\,h^2\,P$$

$$S = \frac{4\,P\,r'^2\,h^2}{\pi\,(r'^4 - r^4)}$$

A numerical value might be substituted for S and value for r' gotten by direct solution, but because r' occurs in the 4th power such a solution would be more or less difficult.

An approximate solution for any given case will be sufficient. That is, suppose we assume $P = 35$ lbs. per sq. ft., $h = 100$ ft.; $r' = 16$ ft., $r = 15$ ft., then S will equal 53 lbs. per sq. in. of section, while if we leave the other dimensions constant and change r' to 15.66 ft., the maximum unit stress will be 82 lbs. per sq. in.

The unit stress due to the concrete may next be expressed as follows:

$$S' = h\,w$$

Where S' = the unit stress for a standpipe of the dimensions given above with $W = 150$ lbs., there results $S' = 104$ lbs. per sq. in. regardless of the thickness of the wall. The total stress on the compression side will then be 157 lbs. per sq. in. when the walls are 12 ins. thick and 186 lbs. per sq. in. when the walls are 8 ins. thick. The compression should not be greater than 200 lbs. per sq. in. because there is already a stress set up by the steel in resisting the water pressure in the standpipe walls.

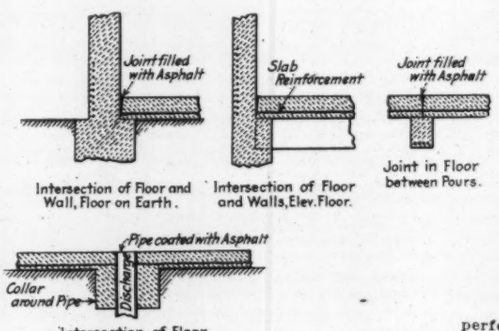
Joint filled with Asphalt
Slab Reinforcement
Joint filled with Asphalt
Intersection of Floor and Wall, Floor on Earth.
Intersection of Floor and Walls, Elev. Floor.
Joint in Floor between Pours.
Pipe coated with Asphalt
Collar around Pipe
Discharge
Intersection of Floor by Discharge Pipe.

Fig. 1. Details of Floor Construction in Reinforced-Concrete Standpipes.

The construction of the floor and foundation of a standpipe is as important as any part of the work. The construction of the floor is usually the last work to be done and invariably should be the last. We believe that generally a mistake is made at this point of the design by thickening up the side walls at the junction of the floor and walls and tying the floor into the walls with steel. Fig. 1 shows the best method of joining the floor to the walls. By adopting this method we make the floor a unit of itself, consequently it is determinate and can be proportioned for thickness when the bearing capacity of the soil is known. The joint shown between the floor and side walls filled with asphalt will be watertight under any head and will remain watertight even though there is some settlement of the wall. The manner of carrying on the work of constructing a standpipe will depend largely on local conditions. The following is the best general method. The foundation up to the bottom of the floor is first constructed at one pour if practicable. Short rods are placed in the foundation to extend at least 30 diameters into the wall above. From the foundation wall, the outside forms are carried up first one length of form timber at the angles are set up to hold the horizontal steel (see Fig. 2). A passage is made through the foundation, preferably where the pipe is to go as this would disturb the soil beneath the floor as little as practicable. If material is taken through the passageway put in the forms from the inside, a staging and hoist being carried up as the work progresses. The vertical angles used for the purpose of holding the horizontal steel are provided with slots or notches to facilitate placing of steel which is wired in place at each bearing by means of a fine flexible wire. The angles can be set in their true positions and blocked away from the forms on the outside and nailed as shown. This method is the most advantageous way of holding the horizontal steel in its true position. The angles are punched to correspond to the required spacing of steel. Then when put in place there will be a slot for each horizontal rod. This does away with a great many mistakes that usually occur in spacing the steel. If the slots in the leg of the angles are cut corresponding to the size of rods used for horizontal reinforcement, the proper arrangement of steel is assured. The inlet and outlet is carried through or under the foundation and up through the floor. A large block of concrete is put around the pipe entrance so as to form a collar having as much surface in contact with the pipe as possible. Just before the concrete is poured for the collar the pipe should be coated with asphalt. The asphalt will form a plastic waterproof connection between the concrete collar and the cast-iron pipe as the concrete sets and shrinks away from the pipe.

The matter of waterproofing a standpipe to prevent absorption is well developed at present, there being many companies advertising materials that will prove successful if properly used. The one disadvantage with the patented waterproofing compounds is the high cost. The writer's experience has been that "Sylvester's Solution," castile soap and alum, will give lasting and perfectly satisfactory results at a much smaller cost than any other known method.

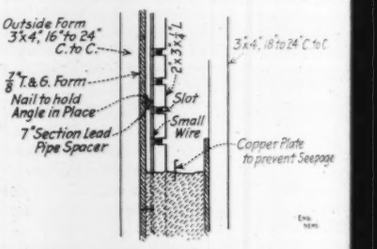
Outside Form 3x4", 16" to 24" C. to C.
2x3x4"L
3x4", 18" to 24" C. to C.
⅞" T. & G. Form Nail to hold Angle in Place
Slot
Small Wire
7" Section Lead Pipe Spacer
Copper Plate to prevent Seepage

Fig. 2. Wall of Reinforced-Concrete Standpipe Showing Method of Supporting Horizontal Rods and Junction of Separate Day's Work.

The price for waterproofing concrete work by the above method will not usually exceed 2 cts. per sq. ft. We have recently completed a job having approximately 5,000 sq. ft. of surface which was waterproofed by the above method for 1.2 cts. per sq. ft.

G. L. Bilderbeck,
Civil Engineer & Supt. of Construction,
War Dept.,
New London, Conn.

Notes and Queries.

A correspondent wishes to know to what extent the so-called "pudding stones," that is, stones larger than the regulation ¾- to 2-in. size, may be used in mass concrete. The standard practice in this regard may be best expressed in the words of a specification for concrete bridges by Mr. Wilbur J. Watson, which reads as follows:

In heavy foundation work or other work requiring large masses of concrete, the contractor may use not to exceed 25% of one-man stones to imbed in the concrete when so indicated on the drawings. Such stones must be sound, clean and wet before placing and shall not be placed nearer than 1 ft. from the surface of the concrete and not less than 6 ins. apart. They must be laid with their largest face at right angles to the line of principal stress.

Hypochlorite Plant for Treating the Water-Supply of Strathcona, Alberta.*

By W. MUIR EDWARDS, Assoc. M. Can. Soc. C. E.

Strathcona is a city with a population of 5,000 situated on the south bank of the Saskatchewan River, directly opposite the city of Edmonton. The public water-supply is drawn from wells sunk in the river bank, and when this source is not sufficient, it is augmented by water taken directly from the river. The water from the wells or river, as the case may be, is pumped into a circular steel tank, into which the suction pipes of the high-lift pumps dip. The water is then forced into the distributing system.

Towards the end of November, 1910, an increase in the number of typhoid cases was noted, and at the request of the Board of Health, the Medical Health Officer and the writer made a systematic study of the cases then in existence. At the same time it was deemed advisable that the water-supply be treated, and an emergency sterilizing plant was therefore installed. Work was started at 10 a. m., Nov. 28, and the sterilizing solution was turned into the supply at 10 minutes past 2 the following morning, a little over 16 hrs. later.

The materials used for the plant were a candy pail, two 50-gal.† bbls., two tubs made by sawing the tops off two other barrels, and the necessary piping, valves, etc. Commercial bleaching powder, after being pulverized and passed through a sieve, was mixed into a smooth paste in the candy pail. Water was then turned on, and the solution allowed to overflow into the barrels which formed the storage tanks. From these barrels the solution flowed through ¾-in. pipes, controlled by valves, into the overflow tubs. From these overflow tubs the solution discharged freely through a curved brass tube of ⅛-in. bore. An overflow pipe was placed so that a head of 6½ ins. was obtained over the orifice. The orifice tubes delivered the solution into the bell mouth of a ¾-in. pipe, which delivered the dosing solution at the center of the mouth of the suction pipe of the high-lift pump. The candy pail was replaced as soon as possible by a metal tank formed by screwing a piece of 12-in. steel pipe into a cast-iron base.

Certain difficulties in operation became apparent during the use of this emergency plant. In the first place, it was found that the method of mixing the solution was unsatisfactory. Secondly, as the flow from the storage tanks is necessarily of a variable nature, and is comparatively small, it was found that the valves became constantly blocked, and at times the flow stopped altogether. The curved tube was also too small, and became clogged and was not easily cleaned out. In fact, it early became apparent that it would be necessary to provide a man to look after the running of the emergency plant alone, and this was done. In the emergency plant the flow of the dosing solution to each of the two suction pipes was received by one pipe, the distribution to either suction pipe being controlled by valves. This was found unsatisfactory, also due to clogging. In fact, our experiment proved the necessity of avoiding valves, flat grades, or angles, all of which are apt to aid the formation of a deposit, thereby interfering with a uniform flow in the pipe.

A study of the outbreak having demonstrated that the epidemic was due to contaminated water, the city council authorized the installation of a permanent plant. This consists of a powdering and sieving box; a rising-current conical mixing tank; three reinforced-concrete storage tanks; two small boiler-feed pumps; drain pipes, water pipes, etc.

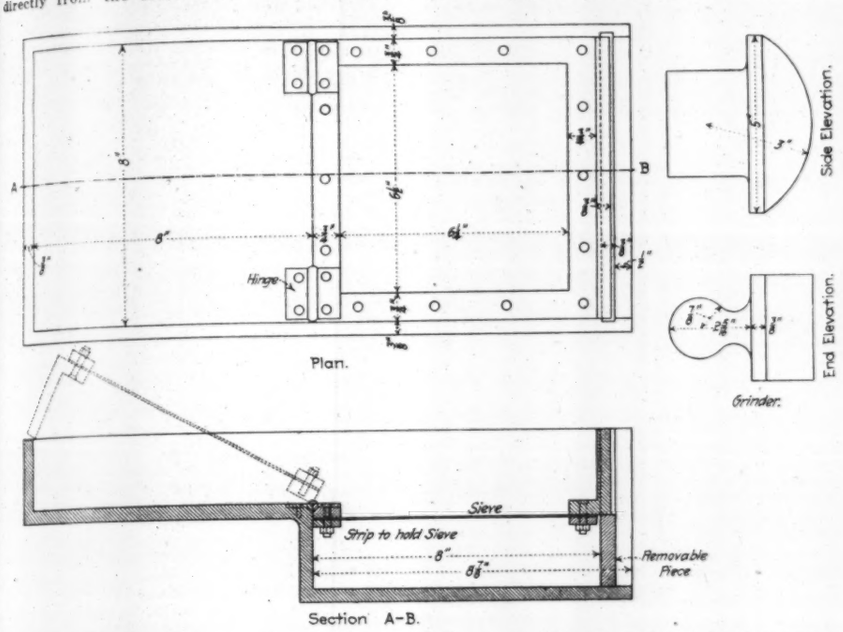

FIG. 1. POWDERING AND SIEVING BOX FOR HYPOCHLORITE PLANT, STRATHCONA, ALBERTA, WATER-WORKS.

POWDERING AND SIEVING BOX.—As will be seen from Fig. 1, the arrangement consists of an oblong box divided into two compartments, the first half being used as a pulverizing surface and the second half as a sieve, through which the powder passes to a compartment below. The framework supporting the sieve is hinged, and can be turned back to rest on the pulverizing surface. By this means the unsieved portion of the powder can be replaced on the pulverizing plate, and when the sieving is complete the sieve may be placed out of the way in order that the mixing of the powder into a paste may be easily done. It may be noted that the front of the lower mixing box can be raised, thus aiding in the working of the paste, and, after being replaced to provide a box in which the paste may be made more fluid, can be again raised to allow the fluid paste to wash into the rising current of the conical mixing tank.

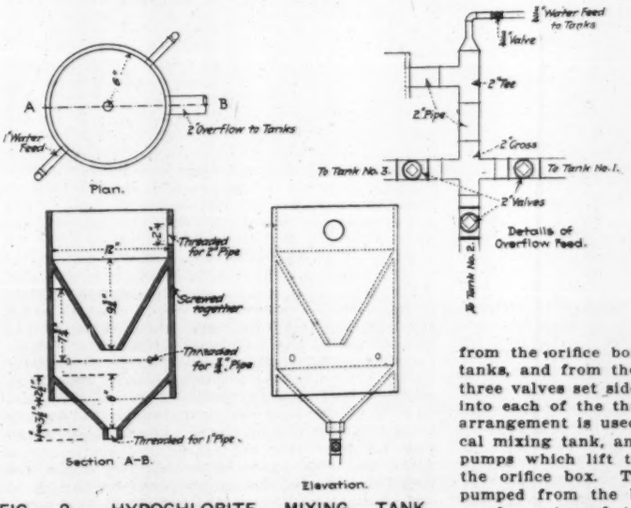

FIG. 2. HYPOCHLORITE MIXING TANK, STRATHCONA, ALBERTA, WATER-WORKS.

RISING-CURRENT MIXING TANK.—Bleaching powder does not go into complete chemical solution in water; when the powder is mixed with water, part is dissolved, but a portion is insoluble. A certain percentage of this insoluble matter has chemical efficiency, and must be retained in the solution if the total strength of available chlorine is desired. In the commercial powder, however, there is a large proportion of inert, insoluble material, and it is advisable to eliminate this as early as possible in the process. The mixing tank shown by Fig. 2 is designed to accomplish this result.

In the design the principle of a rising current of water of varying intensity is used. The arrangement consists of an outer cone, into the side of which two feed-water pipes are led, and from the bottom of which a drain pipe takes away the wasted portion of the powder. Screwed into this cone, and co-axial with it, is a second cone, the opening at the bottom being 1 in., and the diameter of the upper length of pipe being 12 ins., the area of cross-section having therefore the ratio of 1 to 144. When the drain pipe of the lower cone is closed and the feed water turned on, water is forced through the 1-in. opening, and rises in the upper cone. In the face of this upper cone a 2-in. pipe is inserted which connects with the storage tanks. At a point in this overflow pipe a connection is made through which a strong flow of water may be maintained into the storage tanks, the overflow from the upper cone mixing and being carried with it. Thus the rising current in the upper cone can be set to take out as much or as little of the insoluble portion of the bleaching powder as is desired, this part remaining suspended in the lower portion of the cone and being thoroughly washed by the rising water overflowing into the storage tank. It is an easy matter to arrange the two water feeds so that the water in the overflow cone will be quite clear by the time the tank is filled. After the tank is filled the drain cock is opened, and all the insoluble material not carried over in the overflow is washed into the drain and is no further trouble. So far as the author knows this method of treatment is original.

STORAGE TANKS.—These are reinforced-concrete tanks 3 ft. 8 ins. in internal diameter, 5 ins. in thickness, and 5 ft. 8 ins. in depth. A suction pipe for the feed of the pump is inserted 2 ins. from the bottom of the tank, a 2-in. drain pipe is inserted level with the bottom; a 2-in. overflow pipe returns the unused solution from the orifice box to the top of the tank, and a 2-in. pipe enters the top of the tank opposite the overflow pipe and is connected with the conical mixing tank. The tanks are filled within 2 ins. of the top. A single pipe brings the return overflow from the orifice box to a point adjacent to the tanks, and from these three pipes, controlled by three valves set side by side, convey the solution into each of the three storage tanks. A similar arrangement is used for the feed from the conical mixing tank, and for the suction feed of the pumps which lift the solution and deliver it to the orifice box. The fact that the solution is pumped from the bottom of the tank and the surplus returned to the top is relied upon to maintain a uniform strength of solution.

PUMPS.—The solution tanks are set below the pump-house floor. The solution is raised from there to the orifice box by means of a small boiler-feed pump. The capacity of the pump, 5 gals. per min., is much greater than the orifice flow, and thus a good circulation of the solution is maintained. Two pumps are provided, as their size introduces an uncertainty of operation.

ORIFICE BOX.—A steady uniform dosing of the raw water is obtained by orifice flow under constant head. The constant head is maintained

*Abstract of a paper read at the annual meeting of the Canadian Society of Civil Engineers, Winnipeg, January, 1911.

†Presumably Imperial gallons are meant throughout.—Ed.

by the overflow pipes leading the surplus solution back to the tank from which it is pumped. As a variation occurs in the pumping of the raw water, it was necessary to obtain an adjustable feed of the dosing solution. This is provided for by two brass plates faced and held together by a spring. Centered on an arc of the inner plate are 3/16, ⅜ and 7/16-in. holes, suitably spaced. A rotation of the inner plate brings these holes in turn on a line with a ⅝-in. hole in the outer plate. An orifice flow of three degrees of intensity can thus be obtained. The outer brass plate is screwed into an iron plate which is bolted to the face of the overflow box. This box is of reinforced concrete, 3 ins. in thickness. The feed from the solution pumps enters at one end, and the overflow pipe is placed at the opposite end. The details of this box are shown by Fig. 3. Screwed into the outer brass plate is a curved brass tube through which the solution, escaping from the orifice, flows to the bell mouth of a ¾-in. pipe by which it is delivered at the center of the suction pipe of the pump. This ¾-in. pipe is curved and is set with a continuous slope, all

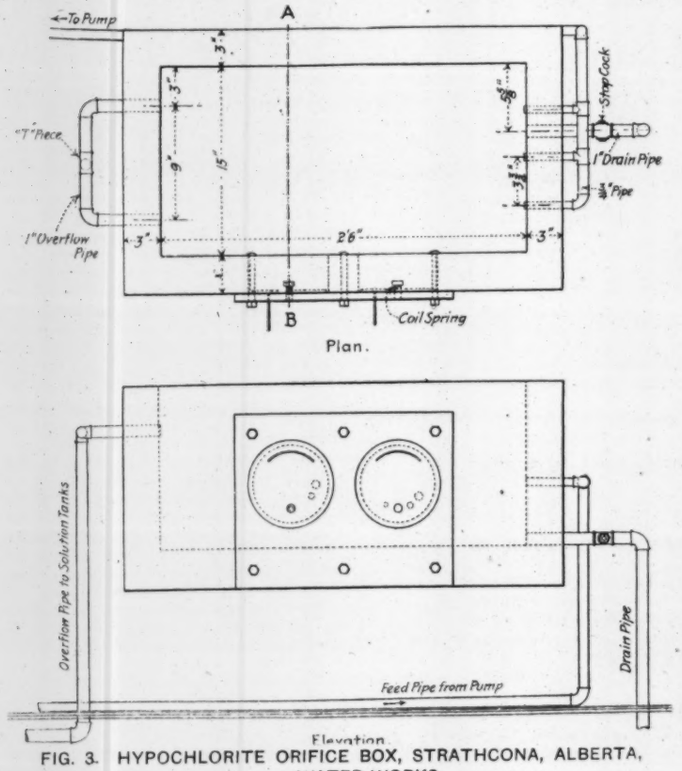

FIG. 3. HYPOCHLORITE ORIFICE BOX, STRATHCONA, ALBERTA, WATER-WORKS.

elbows and horizontal length of pipe being omitted. The solution is taken up the suction pipe with the raw water and there and in the passage through the pump is thoroughly mixed with it.

The question of requiring the engine staff to exercise an oversight over the sterilizing plant is, of course, important. The effort in design has been to eliminate so far as possible the need for careful oversight, and to make the essential features such as will be readily noticed if there is anything wrong. The three tanks hold a supply of solution sufficient for about a 24-hr. run. This means that 20 to 25 mins. is required each shift in filling a tank, and with the rising-current mixer and separator the powder in liquid paste form can be placed therein and in 20 mins. all that is required is a closing of the valves when the tank is full. Too much emphasis cannot be put on the proper sieving, and especially the proper mixing of the powder before it is placed in the rising-current mixer. With the pulverizing and sieving box as shown, this part of the operation can be done thoroughly in five minutes. After the tank is connected to feed the pump and the overflow valves properly set, there is nothing but the stoppage of the pump to be guarded against. The orifice cannot block up, nor is the pipe leading the solution from the orifice to the suction pipe of the pump likely to become clogged. If it does the results are apparent immediately. The pump is in a prominent place and its stoppage would be noticed by the engineman in passing through the engine room. Floats indicate the level of the solution in the tanks, and, in fact, the installation of the plant is such that it does not add materially to the work of the engineer, and there is nothing in the treatment that he cannot do satisfactorily if he so desires. The average engineman does not take kindly to an addition to the routine to which he has become accustomed, but there is nothing in the process itself to give him a legitimate ground for objecting.

EXPERIMENTAL TESTS.—There are two or three matters in regard to the treatment that are of interest and subject to experiment. The author endeavored to obtain some data on these matters that might be of assistance in a study of the subject. In the first place it is interesting to note just how much of the insoluble material can be separated out at the mixing box without interfering with the efficiency of the solution. The possibility of a simple chemical test by which to regulate the dosing is also of interest and likewise to what degree the dosing may be reduced in strength and still act satisfactorily as a sterilizing agent.

As regards the separation of the insoluble matter at the mixing tank two tests were made. In the first place the current in the mixing cone was set so that only the flocculent part of the precipitate was carried over, and all of the rest of the insoluble portion of the powder was allowed to settle out and go to waste. Then the same amount of powder was mixed and a strong current turned on the separator so that practically all of the insoluble portion was carried over into the tank. Samples from each of these tanks were taken and analyzed for available chlorine. It was found that there was no difference in the result, the amount of available chlorine being 110 parts per 1,000,000 in each case.

A test was also made to obtain the efficiency of the overflow and pumping as a mixing device. This did not give results showing a uniform solution, there being a decrease of 15% in the strength of the solution during the emptying of the tank.

Tests as to the possibility of a chemical reaction by which the dosing might be regulated were also carried out. Starch solution, a few drops of weak acetic acid, and two or three small crystals of potassium iodide were added to the treated water, and the latter thoroughly shaken. As has been pointed out, should there be any free chloride present there will result a blue color reaction that is very marked. Tests were carried on at three points on the system, the pump being run at a constant rate and the tower being shut off from that portion of the system upon which the test was being made. The water was tested just after passing through the pumps, at a point at which the water arrived one hour after treatment, and at a point at which the water arrived approximately two hours after treatment. A strong chemical reaction was obtained at the 1-hour station when the water was being dosed at the rate of 22 lbs. per 1,000,000 gals., and a faint reaction was noticeable at 16 lbs. per 1,000,000 gals. at the same station. At the pump house there was a faint blue reaction obtainable when dosing was at the rate of 8 lbs. per 1,000,000, and a marked blue reaction when the rate was 11 lbs. per 1,000,000. The time factor in the reaction is important, but there seems to be no reason why a chemical control of the dosing is not feasible. It was noticeable that at the pump house when the dosing was 7 lbs. per 1,000,000 gals., and the pumps were running at 200 gals. per min., a faint violet reaction was obtained, but at 200 gals. per min. and 4 lbs. per 1,000,000 gals. rate of dosing, the reaction was entirely apparent. There is, of course, a difference of 1 to 3, the first sample being taken 15 mins. after the dosing solution was added to the raw water, whilst in the second sample 45 mins. would elapse between treatment and sampling.

The third point of interest was the possibility that the elimination of the pathogenic bacteria would take place with a smaller dosing than would give the chemical reaction. To test this, samples of the raw water and the water treated, being 1¾, 3½, 5½, 7¾, 11 and 14½ lbs. per 1,000,000 gals.

The bacterial content of the raw water was so low at the time that these tests were made that reliable differential results of the low dosing were not obtainable. It was clearly demonstrated, however, that the chemical reaction might be relied upon as an indication of satisfactory sterilization. It is the intention of the author to repeat these tests during times of higher bacterial content in the raw water.

In conclusion, it might be said that the sterilization of the water-supply eliminated all new cases of typhoid except three or four which could be traced directly to inoculation, the patients coming from houses in which typhoid cases were being nursed. That its continued use has given a feeling of safety to the citizens, and that the physical changes in the water are so little apparent that the author has been frequently asked if the treatment is still going on. The chemical characteristics of the raw water possibly plays a part in these satisfactory results. The water is naturally hard, and it is possible that it is thus not so susceptible to any slight taste introduced by the treatment.

A Flood in China, according to press reports, is devastating the country along the Yangtse-Kiang River for a distance of about 700 miles inland from the coast. It is estimated that thousands of persons have been drowned.

A Derailment on the Wisconsin Central Ry., at Fremont, Wis., Sept. 5, wrecked the "Velvet Special," northbound from Chicago to Duluth. All the eight cars of the train left the track, and three men were killed. The accident is ascribed to a misplaced switch.

The Chilean steamer, "Tucapel," a vessel of 1,912 tons net, was wrecked Sept. 5 on the west coast of South America. A press report from Lima, Peru, states that 81 persons were drowned.

A Passenger Train on the Erie & Pittsburgh line of the Pennsylvania R. R. system was wrecked Sept. 4 at Dock Junction, four miles west of Erie, Pa., by collision with a Lake Shore & Michigan Southern freight train. Four men were killed. The accident is ascribed to disregard of signal lights by the engineer of the passenger train. This train was running 30 minutes behind its schedule time.

A Butting Collision on the Ulster & Delaware R. R., near Halcottville, N. Y., Aug. 31, wrecked the railway pay train and the Rip Van Winkle flier, a fast passenger train. The two locomotives and the baggage car of the passenger train were demolished. One man was killed and several others were injured. The accident is ascribed to a misunderstanding of train orders.

A Derailment of an Express Train on the St. Johnsbury & Lake Champlain R. R. on Aug. 29, caused more or less serious injuries to about 75 passengers. The locomotive, tender, baggage car and first coach left the rails. Both engineman and fireman were seriously injured. The cause of the derailment is reported to have been a washout.

Six Torpedo Boats Were Driven Ashore in the storm which swept over the Georgia and South Carolina coasts on Aug. 27. The vessels were at the Charleston Navy Yard, and were damaged to the extent of several thousand dollars.

An Aeroplane Fall caused the death of Aviator J. J. Frisble at Norton, Kan., on Sept. 1. On the previous day his Curtis biplane had fallen about 40 ft. and was somewhat damaged. His better judgment would have kept him from attempting

a flight, but the jeers of a disappointed crowd of spectators influenced him to the contrary. When about 100 ft from the ground his machine tipped sideways and fell, crushing him under the engine.

Another Bridge Dynamiting was done on the evening of Sunday, Sept. 3, 1911. A four-track steel viaduct being built for the New York, Westchester & Boston R. R. at Mount Vernon, N. Y., by the American Bridge Co., was damaged several thousand dollars. It is thought that nitroglycerine was used.

The Fire Danger of Centering for Concrete was exemplified in two cases which occurred in Europe within the past few months. The most recent was the destruction of a large part of the new railway station at Basel, Switzerland, on Aug. 12, 1911. ("Schweizerische Bauzeitung," Aug. 19, 1911). The walls and roof trusses of the main central part of the station building had been erected, and falsework and lagging had been placed for constructing the reinforced-concrete vaulted ceiling. A fire which started on Aug. 12 found ample material in this falsework, which had become very dry in the long continued hot weather preceding. The side wings of the building and a chemical works several hundred feet distant were saved with difficulty by the firemen.

A Standard Portland Cement Specification for all United States Government work is being looked into by a special committee of government engineers, which has been meeting during the past summer. This committee was appointed to draw up a tentative specification by a conference of government engineers, that first met in Washington, D. C., on June 17, 1911. The draft of this specification was submitted later to the conference and proved acceptable in most particulars. The committee was then instructed to consult with the American Society of Civil Engineers, the American Society for Testing Materials and other similar bodies as to the practicability of developing a uniform specification that might become a generally accepted standard throughout the United States. Such consultation is now in progress. The committee is composed of A. P. Davis, Chief Engineer, U. S. Reclamation Service; J. C. Plant, Supervising Architect's office; Captain W. R. Rose, Corps of Engineers, U. S. A.; Lieut. C. A. Carlson, Corps of Civil Engineers, U. S. N.; S. S. Voorhees, Bureau of Standards; A. E Phillips, Superintendent of Sewers, District of Columbia, and R. J. Wig, Bureau of Standards.

Accidents to Trespassers on Railway Track cost the lives of several thousand persons each year. The greater number of these accidents occur in and about the densely populated industrial centers. The workingmen who use the railway property as a highway and tramps furnish the most victims. Since 1905 the Pennsylvania R. R. has been carrying on a campaign against tramps, and more recently has taken upon itself the task of educating the general public to have more regard for the danger to life and limb of trespassing. In 1905, 887 persons were killed while trespassing on the Pennsylvania R. R. property. In 1910 this number had been reduced to 582, but the figure is still so large as to cause serious attention. While the railways make most of the tramps by furnishing the means of transportation, they do so most unwillingly, for their annual depredations are estimated at several millions of dollars. The railways are more than willing to help in the solution of the tramp problem, and it is with that idea in view that the Pennsylvania R. R. is sending broadcast through its territory papers and circulars designed to create public sentiment in favor of the establishment of state farms for tramps. The same railway is also preparing educational pamphlets in eight languages, which will be distributed through the public schools for the instruction of both children and parents in the dangers of walking on railway tracks.

The Cost of Passaic Valley Sewerage and Sewage Disposal Works (N. J.) will be diminished $1,000,000, it is reported, through the withdrawal of Orange, East Orange, Montclair and Bloomfield from the scheme. Owing to the heavy loss in assessed valuations caused by these withdrawals of territory, the cost to the remaining communities is not lessened by the withdrawals and the reduction in size of outfall and works.

Taking Testimony in the Passaic Valley Sewage Disposal suit (N. J.) began on Sept. 5. The object of the suit is to prevent the Passaic Valley Sewerage Commission from discharging the effluent from screening and sedimentation works into New York Harbor. An otherwise unexplained adjournment of the taking of testimony on the opening day gave rise to a rumor that an effort to effect a compromise was being made.

Intercepting Sewers and Sewage Disposal into Buzzards Bay, New Bedford, Mass., is the subject of a report recently made by Messrs. Metcalf & Eddy, Boston, Mass., on plans prepared by Mr. William F. Williams, City Engineer of New Bedford. The consulting engineers approved Mr. Williams' plans in general, but made suggestions for some changes in detail. The present sewers of New Bedford are partly on the separate and partly on the combined system, with discharge at 31 points on the Acushnet River and eight points on Clark's Cove, at or near low-tide level. It is proposed to construct two intercepting sewers along each of the water fronts named and join these in a single sewer to be carried to Buzzards Bay, beneath which a 60-in. cast-iron pipe about 3,000 ft. long will be laid with a number of orifices near its end to aid in the dispersion and diffusion of sewage in the bay. A pumping station will be required. The consulting engineers advise that the capacity of the sewer be based on a maximum rate of discharge of 400 gals. per capita per day for the estimated population of 30 years hence, or a total outfall capacity of 88,000,000 gals. They also propose a circular cross-section for the sewer, except that at the end a horseshoe or elliptical section would be used, on account of water level and lack of cover. The sewer would increase by 6-in. stages from 36 to 78 ins. in diameter and then change to the other type of cross-section suggested, which would be 84 ins. in vertical diameter, or the equivalent of a 90-in. circular sewer. Concrete is suggested by the consulting engineers as the material for the sewer, but with either an increase of 2 ins. in thickness or an interior lining of brick at points where there might be an admixture of salt water. An interesting part of Mr. Williams' plan was a scheme for washing the sand collected in the grit chamber at the lower end of the outfall sewer, the idea being to utilize the sand. The consulting engineers suggest

that either Mr. Williams be given authority to make experiment upon the possibility of ejecting and washing, by ejectors similar to those used so successfully in slow-sand water-purification plants, the grit and inorganic material likely to be separated from the sewage in the grit chambers, or that the grit chamber be built on lines heretofore used, with suitable provision for converting it into the form of chamber suggested for use by Mr. Williams. This can be done without substantially increasing the cost of construction for the changes which will be required in case the devices suggested by Mr. Williams should not prove able to handle the character of materials encountered. If, on the other hand, the suggested devices prove effective, they will save the city substantial expense in operation. Therefore as their cost of installation is but nominal, we believe the experiment justified.

Messrs. Metcalf & Eddy do not think that disinfection of the sewage will be necessary, but should a contrary conclusion finally be reached they advise sedimentation basins for the removal of "the greater portion of the suspended organic, as well as inorganic, matter contained in the sewage," so that the calcium hypochlorite would be applied to settled rather than to crude sewage. The estimated ultimate cost of construction is put at $1,526,000 by the consulting engineers, or $1,186,000 immediately. The difference is accounted for by a future second outfall and two additional pumping stations.

We are informed by Mr. Williams that the contract for supplying the cast iron pipe has been awarded and that bids for laying it will be received on Sept. 6; also that plans for the first section of the intercepting sewer are being made. A final decision as to the grit chamber and the sand-washing project has not yet been reached.

The Chicago Elevated Railways have at last been consolidated and put under the control of a single company, which is named the Chicago Elevated Railway Co. It is expected that this will result in a better system of operation of the elevated loop line in the business district, and in the through routing of trains from one part of the city to the other. Under four separate companies no such arrangement has been possible, in spite of frequent attempts by the city and other interests, and the trains of each line have traveled around all four sides of the loop in order to pass out at the same point where they entered. A system of transfers and through fares is being urged by the city, but as yet no changes have been made. The new system comprises about 70 miles of line and an equipment of 1,600 cars (including motor and trail cars). The lines included are as follows: Metropolitan Elevated Ry., 25 miles; Chicago & Oak Park Elevated Ry., 11 miles; South Side Elevated Ry., 19 miles; Northwestern Elevated Ry., 10 miles; Union Elevated Ry. (Loop), 4 miles. Mr. B. I. Budd has been made President of the new consolidated company.

A Boiler Explosion, Sept. 1, wrecked the German government steamer "Strew," near the mouth of the Oder River. Reports state that eighty persons were killed and two others injured.

A Bridge Under Construction Collapsed at Bruil, Switzerland, six miles south of St. Moritz, Aug 29, carrying with it some 30 workmen, 15 of whom were killed outright. The bridge was designed to carry a railway over a deep gorge.

A Peculiar Mine-Cage Accident, Sept. 3, in the shaft of the Black Rock mine, near Butte, Mont., caused the death of six miners. A load of dull drill steels was being hauled to the surface on the cage, and the six men boarded the cage to ride up with the steel, in violation of the mine rules. According to press reports, the drill steels became dislodged during the ascent so that some of them projected from the cage and struck against the sides of the shaft. This caused their other ends to thrash about in the cage. The men were bruised and mutilated by the steels and, according to reports, were finally swept from the cage, falling 1,400 ft. to the bottom of the shaft. The mine is the property of the Butte-Superior Co.

The World's Railways.—World-wide statistics accumulate only slowly, but it is computed that, at the close of 1909, there were 625,698 miles of railway in operation on the globe. This total did not include street railways and trolley lines. The two Americas had between them 319,344 miles of completed railway, while Europe and Asia had only 266,704 miles between them. Africa had 20,829 miles in operation and Australasia 18,849 miles. The additions made to completed railway in Europe in 1909 amounted to 2,528 miles; in Asia, to 2,986 miles; in Africa, to 1,789 miles; in North America, to 4,143 miles; in South America, to 1,866 miles, and in Australasia, to 882 miles. Although North America has obtained a long lead in the matter of railways, construction on that continent is now proceeding at a reduced rate. Asia has now a by no means unimportant railway network, although there is room for great further extensions. Russia built, in 1909, 1,258 miles of railway in Central Asia. In 1909 China had 5,277 miles of railway in operation, of which 3,050 miles had been opened in the four years ending with that date. Japan only opened out 45 miles of new line in 1909. Argentina comprises more than one-third of the railway mileage of South America, having 15,854 miles of completed line in operation in 1909. Brazil ranked second, with 13,000 miles. Cuba and the West Indies (which are included in the South American compilation) had 4,340 miles of railway in the year under review. The amount of capital invested in the railways of the world in 1909 is computed at £10,320,000,000.—["The Engineer," London].

The Cost of Manufacturing Concrete Piles on the Panama Canal is given in the accompanying table issued by the Isthmian Canal Commission. The sectional size of the piles or the amount of reinforcement is not given, but these items affect but slightly the total cost of concrete piles. The data are for three months in 1911.

	April.	May.	June.	Total.
Quantities—lineal feet	10,002	5,904	5,760	21,666
Costs per lin. ft.				
Cement	$0.1024	$0.0828	$0.0760	$0.0900
Stone	.0750	.1176	.1145	.0971
Sand	.0178	.0255	.0080	.0173
Mixing	.0358	.1157	.0512	.0617
Placing	.0334	.0711	.0323	.0434
Reinforcements	.8584	.7276	.6346	.7734
Forms	.0922	.0344	.0786	.0729
Maintenance of equipment	.0053	.0054	.0114	.0069
Plant arbitrary	.1794	.1700	.1700	.1742
Division expense	.0114	.0170	.0210	.0155
Total cost per lineal ft.	$1.4111	$1.3671	$1.1976	$1.3525

The Commission Form of City Government was voted down at Paterson, N. J., on Aug. 29, by a vote of 7,984 to 4,917. The heavy adverse vote is said to have been not so much a condemnation of the commission plan as an endorsement of the administration of Mayor McBride. Mr. McBride was against the commission plan.

Irrigation Statistics for Nebraska and for Oklahoma, just issued in a preliminary statement made by the U. S. Bureau of the Census, show that in 1909 Nebraska had a total irrigated area of 256,350 acres against 148,538 in 1899, or an increase of 72.6%; and that Oklahoma had 2,759 acres under irrigation in 1899 and 5,402 acres in 1909, or an increase of 95.8%.

Personals.

Messrs. Walter S. Dickey and Lawrence F. Jones of Kansas City, Mo., have resigned as members of the State Waterways Commission of Missouri.

Mr. Ralph D. Brown, formerly Assistant Engineer of the O'Gara Coal Co., Harrisburg, Pa., has been appointed Instructor in Civil Engineering at the Missouri School of Mines, Rolla, Mo.

Mr. Harry M. Lee, Assistant Engineer of the Water Department of Springfield, Mass., has resigned to accept a position with Hazen & Whipple, Consulting Engineers, of New York City.

Mr. J. P. Snow, M. Am. Soc. C. E., who recently resigned as Chief Engineer of the Boston & Maine R. R., has opened an office at West Somerville, Mass., for the practice of general engineering.

Mr. John Purcell, Superintendent of Shops for the Atchison, Topeka & Santa Fe Ry. at Topeka, Kan., has been promoted to Superintendent of Shops for the entire Santa Fe System, and will have charge of 15,000 employees.

Mr. C. N. Harrub, Assistant Engineer of the Water Department of Springfield, Mass., in charge of the Little River filter plant, has resigned to accept a position with the New Jersey State Board of Health at Trenton, N. J.

Mr. Everett Fowler of Kingston, N. Y., has been appointed Deputy State Fire Marshall, and Mr. Peter A. Acritelli, of New York City, Second Deputy State Fire Marshall of New York, with salaries of $5,000 and $3,000 per annum respectively.

Mr. R. A. Thompson, M. Am. Soc. C. E., formerly Chief Engineer of the Wichita Falls & Northwestern Ry., at Wichita Falls, Tex., has been appointed Engineer of the State Railroad Commission of California at a salary of $5,000 per annum.

Mr. Edwin K. Morse, M. Am. Soc. C. E., of Pittsburgh, Pa., has been appointed Consulting Engineer for the city of Pittsburgh in the construction of North Side Reservoir, to be built at a cost of $2,000,000, and on other projects to cost $5,000,000 more.

Mr. J. H. Nuelle, formerly Assistant Engineer of the New York, Ontario & Western R. R., at Norwich, N. Y., has been appointed Principal Assistant Engineer at Middletown, N. Y., for the same road, succeeding Mr. J. C. Bently, Assoc. M. Am. Soc. C. E. resigned. Mr. D. W. Fagley, Jr., succeeds Mr. Nuelle at Norwich.

Mrs. Mary E. Ewing, widow of the late William Bion Ewing, M. Am. Soc. C. E., of Chicago, Ill., will continue his unfulfilled engagements in municipal work, according to a newspaper report. The same report states that Mrs. Ewing has formed a company, of which she is the head, to engage in the design and construction of sewage-disposal and water-supply plants.

Obituary.

Frank R. Long, a prominent bridge contractor of Hackensack, N. J., died on Aug. 30. He was President and Manager of the Frank R. Long Construction Co., and was contractor for building several bridges across the Hackensack River and other streams near New York City. He was a member of the Hudson River Bridge Commission for New Jersey.

R. M. McCoy, Division Engineer, and C. S. Nelson and F. R. Drum, Resident Engineers, of the Canadian Northern Ry., were drowned last week in Lake Helen in Ontario, north of Lake Superior. The men left camp on Aug. 27 for Nepigon, and on Aug. 30 their overturned canoe was found in the lake. Mr. McCoy was 48 years old and is reported to have come from Spokane, Wash.

Rexford J. Lyon, Assistant Engineer in charge of the main intercepting sewer under construction in Syracuse, N. Y., and Mr. Oliver K. Harwood, also an engineer of the Syracuse Sewer Department, were overcome with gas and drowned in a sewer in the heart of Syracuse, on Sept. 1. Mr. Lyon was a son of Deputy State Highway Commissioner Frank D. Lyon, of Binghamton, N. Y., and was 42 years old and single. Mr. Harwood was a graduate of Syracuse University and formerly famous as an athlete; he was about 30 years old and was married about a year ago.

James M. Wisler, Superintendent of the Toledo City Water Works, and six companions, who were also officials or employees of the city, were drowned by the sinking of a 35-ft. launch in Toledo harbor on Sept. 2. The party was on a fishing trip when their launch was run down by a large freight steamer. The launch was almost cut in two and the men drowned were caught in the forward end. The sole survivor was in the other end at work on the engine. Mr. Wisler was 48 years old and was a former railroad man.

Engineering Societies.

COMING MEETINGS.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
Sept. 12-15. Annual meeting at St. Paul, Minn. Secy., Clarence R. George, Houston, Tex.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 12-15. Annual convention at Atlantic City, N. J. Secy., A. P. Dane, Boston & Maine R. R., Reading, Mass.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION.
Sept. 12-15. Annual meeting at St. Louis, Mo. Secy., W. E. Emery, Peoria, Ill.

COLORADO ELECTRIC LIGHT, POWER AND RAILWAY ASSOCIATION.
Sept. 13-15. Annual convention at Glenwood Springs, Colo. Secy., F. D. Morris, P. O. Box 1052, Colorado Springs, Colo.

NEW ENGLAND WATER WORKS ASSOCIATION.
Sept. 13-15. Annual convention at Gloucester, Mass. Secy., Willard Kent, Narragansett Pier, R. I.

AMERICAN ASSOCIATION FOR LABOR LEGISLATION.
Sept. 15-16. Conference at Chicago, Ill. Secy., John B. Andrews, 1 Madison Ave., New York City.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 19-21. Annual convention at Spring Lake, N. J. Secy., N. T. Wilcox, Lowell, Mass.

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Sept. 19-22. Annual convention at Milwaukee, Wis. Secy., James McFall, Roanoke, Va.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 21-23. Annual meeting at Toronto, Ont. Secy., Jos. W. Richards, Lehigh University, South Bethlehem, Pa.

AMERICAN PEAT SOCIETY.
Sept. 21-23. Annual meeting at Kalamazoo, Mich. Secy., Julius Bordollo, Kingsbridge, New York City.

MICHIGAN GAS ASSOCIATION.
Sept. 20-22. Annual meeting at Detroit, Mich. Secy., Glenn R. Chamberlain, Grand Rapids Gas Light Co., Grand Rapids, Mich.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 25-27. Annual convention at Chicago, Ill. Secy., Preston S. Millar, 29 West 39th St., New York City.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Sept. 26-28. Annual convention at Grand Rapids, Mich. Secy., A. P. Folwell, 239 West 39th St., New York City.

AMERICAN MINING CONGRESS.
Sept. 26-29. Annual session at Chicago, Ill. Secy., J. F. Callbreath, Denver, Colo.

LEAGUE OF AMERICAN MUNICIPALITIES.
Oct. 4-6. Annual convention at Atlanta, Ga. Secy., John MacVicar, Department of Streets, Des Moines, Iowa.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Annual convention at Atlantic City, N. J. Secy., H. C. Donecker, 29 West 39th St., New York City.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Oct. 10. Annual convention at Washington, D. C. Secy., Wm. H. Connolly, Washington, D. C.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Oct. 10-17. Annual convention at San Francisco, Cal., followed by trip to Japan. Secy., Joseph Struthers, 29 West 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Oct. 10-12. Annual convention at Colorado Springs, Colo. Secy., C. C. Rosenberg, Bethlehem, Pa.

LAKES-TO-THE-GULF DEEP WATERWAY ASSOCIATION.
Oct. 12-14. Annual convention at Chicago, Ill. Secy., Thos. H. Lovelace, Bank of Commerce Bldg., St. Louis, Mo.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Annual convention at St. Louis, Mo. Secy., C. A. Lichty, C. & N. W. Ry., Chicago, Ill.

AMERICAN GAS INSTITUTE.
Oct. 18-20. Annual convention at [illegible] Louis, Mo. Secy., A. B. Beadle, 29 West [illegible] St., New York City.

Society of Naval Architects and Ma[illegible] Engineers.

After the annual meeting in N[illegible] York City, Oct. 16-17, a banquet will be held at the Waldorf-Astoria Hotel, at which the John [illegible] medal will be presented to Sir William White.

Lakes-to-the-Gulf Deep Waterway Association.

The sixth annual convention will be held at the Auditorium Theatre in Chicago, Oct. 12-14. The secretary is Mr. Thomas H. [illegible]velace, 914 New Bank of Commerce Bldg., St. [illegible]uis, Mo.

International Association of Fire Engineers.

In connection with the annual convention, Sept. 19-22, at Milwaukee, Wis., will be held the largest exhibit in the history of the organization. The apparatus shown will include 3[illegible] motor-driven pieces, including engines, hook-and-ladder trucks, combination wagons, hose wagons and chemical engines.

Colorado Association of Members of the American Society of Civil Engineers.

The September meeting will be held at the Colorado Traffic Club at Denver, Colo., on the evening of the 9th. Following the regular informal dinner, Mr. V. A. Kauffman, Assoc. M. Am. Soc. C. E., will present a paper on "The Design and Construction of the Alameda Subway," an interesting structure which has recently been completed in Denver. Mr. G. H. Houston, 409 Equitable Bldg., Denver, Colo., is Secretary.

Philippine Society of Engineers.

This society, organized in February, 1910, has just published Volume I. of its "Proceedings." The first meeting was held July 30, 1910, at the Army and Navy Club in Manila, and the following officers were elected to serve until the next annual meeting: President, L. F. Goodale; Vice-President, C. G. Wrentmore; Secretary, G. K. Larrison; Treasurer, C. W. Keith; Trustees, C. W. Hubbell, H. P. Linnell and Wm. H. Robinson. Regular meetings for the presentation of papers were held in September and November, 1910.

At the annual meeting, Jan. 3, 1911, in Manila, new officers were elected as follows: President, C. G. Wrentmore; Vice-President, H. P. Linnell; Secretary; E. R. Frisby, P. O. Box No. 660, Manila, P. I.; Treasurer, S. O. Scudder; Trustees, L. F. Goodale, H. L. Higgins and Warren D. Smith. The charter membership was 17 and the total membership at the time of publication of the "Proceedings" was 50.

New England Water Works Association.

The 30th annual convention will be held at Gloucester, Mass., Sept. 13-15. On Wednesday, Sept. 13, there will be a business meeting and reports by the various committees. At 2.30 o'clock in the afternoon Mr. W. H. Richards, Engineer and Superintendent of the Water and Sewer Department of New London, Conn., will present a paper on "Coming Efficiency in Water Works Management." Following this will be a paper by Mr. A. J. Provost, of New York City, on the "Protection of New York's Water Supply from Pollution during Construction Work." At the evening session two papers will be read, one "The Filtration of Salt Water," by Mr. Robert S. Weston, of Boston, Mass., and the other "Hudson River Crossing of the Catskill Aqueduct," by Mr. Robt. Ridgway, Department Engineer, Board of Water Supply, New York City. At 10.00 o'clock Thursday morning Dr. Hardolph Wasteneys, of the Rockefeller Institute of Medical Research, New York City, will read a paper entitled: "A Short Account of Some Purification Experiments with a Surface Water in Queensland, Australia." The remainder of the forenoon will be devoted to topical discussion in which it is expected that some interesting experiences regarding the increase of water consumption during the recent hot weather will be presented. The paper of the afternoon session will be "Organization and Efficiency," by Mr. Ermon M. Peck, of Hartford, Conn. At the evening session Mr. Alfred D. Flinn, Department Engineer of the Board of Water Supply, New York City, will present a paper on the "Protection of Steel Pipes in the Catskill Aqueduct," illustrated by lantern slides. On Friday (Fish Day) the members of the association will relax from their weighty deliberations and enjoy a fishing trip in one of Gloucester's deep-sea fishing vessels, as the guests of the Water Commission of Gloucester. Messrs. William E. Maybury, of Braintree, Mass., and John W. Moran, of Gloucester, Mass., are the Committee of Arrangements.